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MOONLIGHT TABLES.

This year, as for many years past, Mr. H. W. Frund, the well-known central station manager, has prepared for us moonlight tables for street lighting work, to be used in 1904. With the present issue we furnish these tables in the wonted form of a supplement. We are glad to know that this effort is very much appreciated by our numerous central station readers. Extra copies may be obtained on application to the business department of this journal.

SINGLE-PHASE ELECTRIC TRACTION.

Elsewhere we print a paper by Mr. Paul M. Lincoln discussing the relative merits for certain traction service of direct and single-phase alternating currents, which forms the most valuable contribution to the general engineering side of the subject which thus far has been made in this country. As the views of Mr. Lincoln may be assumed to reflect those of one of the two great companies in this country controlling the manufacturing side of the electric railway industry, the paper for this reason has a special interest and importance. One of the most remarkable features to be noticed in the growth of the electrical industry is the manner in which, when the industry apparently seems to have settled down to a normal growth along well-defined lines, a new development suddenly occurs which reveals an unexpected prospect of further fields to conquer. Two years ago single-phase electric traction had no standing except with a few engineers who were quietly working on the problem of the single-phase commutator motor, and whose faith has been so amply justified by recent developments. Beginning with the announcement of the Arnold and the Lamme single-phase railway systems, and followed by the Winter-Eichberg and Finzi developments in Europe, single-phase traction has, particularly during the past few months, assumed an interest and importance that at present make it overshadow everything else of the kind in the electrical field. The paper of Mr. Lincoln, to which we shall return in another issue, furnishes evidence that the interest which has so rapidly sprung up is not without reason. While it does not specifically pronounce in favor of the single-phase system as against the present direct-current system, yet so far as essentials are concerned, the comparison is decidedly favorable to the former; and as it is based upon a survey of the entire situation with a consideration of all the factors involved, both technical and commercial, its message is one that carries conviction with it. This is a great electric traction era.

THE INDEPENDENT TELEPHONE CONVENTION.

We are able to furnish our readers this week by telegraph a lengthy account of the Independent Telephone Convention, which is still in progress as we go to press. It would appear that the convention has as usual attracted considerable attention and is likely to be attended by good results. It is evident that the body could not stand still in these stirring times of telephonic progress, and a quite considerable programme is outlined both in the presidential address of Mr. Hull and in the secretarial report of Mr. Coleman. The latter, in his report, presents, moreover, some figures which are quite striking as to the relative capitalization of the Bell interests and the Independent interests, claiming a capitalization per subscriber under the Bell system of $417, and of only $100 per subscriber under the Independent régime. It strikes us, however, that these figures are a little bit open to question. We have seen it stated, and our own observa-

tion would confirm it to some extent, that in a great many of the Bell companies the capitalization per subscriber runs between $200 and $250, instead of over $400, as stated by Mr. Coleman. Moreover, it will, we believe, be conceded that the Bell systems represent a great deal more in the way of investment in the shape of underground wires and elaborate exchanges than the Independents yet do, except in a few of the larger cities, it being a universally recognized fact that the Independent movement has worked up the cheaper subscriber and has conferred a great boon on the public by placing the telephone in the hands of those who were not reached by the Bell system or covered by the Bell rates. The extent to which this movement has gone is well exemplified in Mr. Coleman's own statement, that in the commonwealth of Iowa alone there is the extraordinary number of 1,200 independent telephone companies.

THE FINZI MOTOR.

Recent reports indicate that Dr. Finzi has developed in his alternating-current railway motor, a machine that possesses some very remarkable properties. It is the more interesting in that it is a reversion to the series type, modified for alternating-current work by laminating the poles, designing for low inductance and using high-resistance commutator leads. So far as the data now before us show, the excellence of the result is almost wholly due to skillful design and not to any radically new features. It is certainly a notable feat to have replaced a standard direct-current railway motor on a standard car by an alternating-current motor and to have obtained anywhere nearly the same working qualities after the change. But this Dr. Finzi seems to have done, and his motor is said to have run with very slight sparking and at good efficiency. Its power factor anywhere near full speed is high, although undeniably low in starting. Still, in the experiments tried the acceleration attained was sufficient to meet the requirements and the volt-amperes were not much greater with the alternating than with the direct-current motor. We are not disposed to be over enthusiastic on the results of a few tests, but it certainly looks as if this alternating motor deserved respectful consideration, like the Winter-Eichberg motor described some weeks since, and concerning which we shall have more to say later. With these and the alternating motors developed by American companies, there is material at hand for practical work. We have often expressed the opinion that alternating motors for traction are highly desirable in view of the matter of distribution to large systems, and it is certainly encouraging to have promise of machines not only capable of use in interurban work, but of competing with direct-current apparatus in ordinary tramway systems. We hope the new motors will be given an early trial on a practical scale. In the case of the Winter-Eichberg system this is not far distant, a contract with rigorous guarantees having, we learn, lately been closed by the Union Electricitäts Gesellschaft for the equipment of a Belgian railway.

CONSERVATIVE VIEWS OF THE ZOSSEN TRIALS.

These pages were among the first to insist upon the great importance of the high-speed railway trials at Zossen from the engineering standpoint, and we have not been chary in expressions of appreciation for the brilliant work of the German engineers who brought them to such a successful conclusion. Now that the technical achievement has entered into electrical engineering history, to which it furnishes one of its finest pages, the question arises, What will be the practical outcome? On this point a definite conclusion must, of course, await data—now entirely lacking so far as the general engineering public is concerned—on the costs of road construction, equipment and operation. In certain circles in Germany, however, there is much skepticism as to the future bearing of the Zossen work, and having presented the optimistic side, we feel that currency should also be given to the conservative view as held by some competent German engineers and perhaps by most State railway officials.

According to these, the only positive result which the Zossen tests have shown is the certainty that present roadbeds and track construction are far from being suitable for speeds above 90 to 100 miles. Previous to the Zossen experiments there was no real doubt that speeds up to and above 125 miles could be attained, and the real question, which remains undetermined, was whether such speeds could be utilized in practice. Practical test has shown that there is rapid deterioration of the road structure under high speeds, and it is, therefore, held that the question has been settled negatively, at least for the present. While it might be claimed that a track of the requisite strength for high-speed railways could be built, this involves installing entirely new roads for high-speed service, which service would not permit any other kind of traffic on the same line. The roadbed for such work could not be built by using a dirt subconstruction with wooden ties and gravel ballast, but must be built massively throughout of brick and cement. Moreover, to insure safety the outward and return tracks must be at least 30 ft. apart on account of windage from passing trains. It is held that the cost of a road of this construction and width of way between Berlin and Hamburg would be so enormous that its realization is out of the question for years to come. To make it even fairly profitable at least 60,000 passengers would have to be transported daily, and traffic of the necessary volume cannot be looked for even between the largest German cities. While these views reflect the opinion of men who probably have had opportunities for a closer view of the Zossen experiment than the general engineering public, yet nevertheless until the complete data of these trials are available, and particularly until information as to the roadbed and track and the manner in which they held up under the trials, is published, the question of high-speed traction will remain an open one. It is sincerely to be hoped that the Research Syndicate under whose auspices the trials were conducted will see fit to make public a complete report on the subject, especially since the absence of full information is apt to fortify the skeptical opinions we have noted.

ECONOMY IN PUBLIC LIGHTING.

A recent number of *Engineering* contains a most instructive study in public lighting made for the city of Westminster. It includes tests of the various illuminants there used both as to their actual candle-power and their cost. The list includes arc lamps and various forms of gas burners, ranging from mantle burners worked under high pressure down to common flat flame burners of the type generally discarded in this country. The report containing the data is the fifth quarterly report on the subject, so that the public lighting may fairly be said to be under systematic test, a condition rarely fulfilled in American cities. The costs are reduced to a candle-power-year basis and range from 92.6 cents per candle-year for the flat flame gas burners down to 18.8 cents for the best arcs and 18.24 cents for the intensive mantle burners. Perhaps the most striking fact brought out is the relatively uneconomical result attained by the ordinary mantle burners, which have been so industriously exploited in this country. The cost per candle-year for these lamps was just about 34 cents, or roughly, 50 per cent. more than the average cost with arc lamps. This increase seems to be mainly due to the high cost of maintenance which amounted to between $5 and $6 per year for each burner. It is to be hoped that the Westminster mantles were kept up better than is the custom here, else such figures would be doubly discouraging. Street service seems to affect mantles very rapidly, and while a street lighted with mantle burners often presents a most alluring appearance at its first public view, a visit some weeks later is quite certain to give an impression of greenish

dinginess that is extremely depressing. The Board of Aldermen are usually "first-nighters" while the citizens in general have to take the performance as it goes.

Tests such as we are quoting are excellent so far as they go, but they fail to take into account the quality and distribution of the light, both very important factors in its general worth. The advocates of mantle burners generally raise their voices bravely to shout for uniform distribution and drop them to a sepulchral whisper when speaking of quality. It is beyond question that a large number of low-power lamps will distribute light more uniformly than a few powerful radiants, but the general result in the street is seldom improved by uniform distribution unless the lighting is planned on a very liberal scale. If a certain fixed minimum is the criterion of good illumination in a street, the common candle would have some claim for consideration. On the other hand, if the criterion be maximum brilliancy, then the bigger the individual units the better. In actual street illumination neither of these criterions is sufficient. The brilliancy should be everywhere above a certain minimum, but beyond that an effect is to be produced which must be judged upon its merits. It is a well known fact that this general effect depends upon many things besides candle-power. For instance, it has been shown by experience that enclosed arcs which burn very steadily can replace with excellent results open arcs of materially greater power. The general effect gains from the steadiness and slight better distribution more than it loses by the decrease in total light. This matter of general useful effect has a much stronger influence than is commonly supposed, and there is no doubt that photometric measurements have small weight with those who pay the bills as compared with the effect on the streets which is apparent to the eye.

Judged in this way, the advantage generally lies with the more powerful radiants, and the mantle gas burners of the ordinary kind make a very poor showing indeed. If economy be not their merit they have no other, and this Westminster (London) showing leaves little good to be said of their economy. What the intensive mantle burners may do remains to be seen, but even they give small promise of sufficient economy to compete actively with the best arcs.

ELECTRIC RAILWAYS OF THE UNITED STATES.

We have commented more than once on the Census Office Bulletin on Street and Electric Railways, which, notwithstanding its statistical form, is so replete with live interest to all connected with the interest it represents that to these its pages are more absorbing than the latest novel. Almost every table tempts one to deductions, and even the habits of different sections of the country may be uncovered by analysis of forbidding columns of figures. At each study new incidental points appear. For example, the figures show that in the South Central States each inhabitant takes a little over one ride per month, while in the North Atlantic States he takes a ride every third day. Consequently, the street-car go-about tendency of the Yankee is some eight times greater than his south-central relative. Another interesting deduction is with relation to the figures of casualties. Though these in 1902 reached the formidable total of almost 50,000, of which about 2½ per cent. were fatal, an examination relieves any misapprehension as to the serious bearing of these statistics. Restricting ourselves to passengers, which form 27,000 of the total, if we assume each ride in a car to average half an hour, then each person would expect to ride day and night for about 11 years before getting injured, and for more than a thousand years before getting killed. The average street car is, therefore, a safe place to stay in. It is only the occasional street car that is so fatal.

There is nearly enough single trolley track in America to encircle the globe. Each mile of single track in 1902 earned on the average $11,000 per annum, or about one dollar per foot of single rail. Each single-track mile cost about $6,300 per annum to operate, or about 57 per cent. of the average earnings. There were about six employees per mile of track, excluding salaried officers, and about 27 passenger cars. This means about 2¼ men per car installed. Dividing the 4,800 millions of passenger fares collected by the number of cars, each car installed provided on the average 80,000 passenger rides per annum, or 220 per diem. In 1890 the cars were only about half as numerous, and the cars per mile were 4, or averaged ¼ mile apart, being thus more crowded than they are now; the number of employees per car was just about the same as at present, while the annual passenger rides per car were about 62,000, or 171 daily. By the large extension of the trolley system the annual road earnings per man employed increased from $1,280 in 1890 to $1,850 in 1902. With the aid of the improved electric machinery each man at work was able to do nearly 50 per cent. more service to the community, as judged by the returns paid by the community. Some share of this increase should, however, be attributed to increase in population.

Half of the passenger cars, nearly half of the track, and more than half of the paid-passenger rides occur in the North Atlantic States; while the greatest rate of increase on relatively smaller numbers is found in the South Atlantic States. Each inhabitant of the United States takes, on the average, a street car ride 63 times a year, which is twice as often as he, she or it did in 1890. This means at present rather more than one car ride per week. The prime motor machinery installed in 1902 amounted to nearly one million kilowatts, of which only about 4 per cent. was hydraulic, 96 per cent. being in steam engines. There were on the average about three engines in each power house, and each engine averaged 400 kw. The dynamo machinery installed aggregated approximately the same total as the engine power. About one-sixth of the dynamo installation was of the alternating-current type, and five-sixths direct current. Each power house contained on the average four generators of 300 kw each, the average size of the alternating current being 400 kw and of the direct-current machines 250 kw. The total output was such that all the generators installed would supply it, if worked at full load for seven hours daily. The largest installation of any one operating company was 60,000 kw. The total passenger car-mileage for the year 1902 was over one billion car-miles, or more than enough for one car to reach the planet Saturn at his greatest distance from the earth.

Glancing at labor again, as tabulated, the industry employs over 140,000 men directly, apart from those who are employed in making supplies. These men receive about $88,000,000 annually in salaries or wages, representing about $625 annually per man. The total wages of the street railway system of the United States amount, therefore, to about one-quarter of a million dollars daily. Practically all of this industry belongs to the applications of electricity, and represents the outcome of the last fifteen years of electrical progress. In these fifteen years about one million kilowatts of electric dynamos have been built and installed. If the average car equipment of motors be rated at 33 kw, the total amount of motor capacity constructed and installed in the same time is about two millions of kilowatts, not counting the amount that has been worn out or discarded. If a monument were needed to the success and benefits of modern engineering in general and of electrical engineering as a particular branch thereof, in meeting the demands of the age, we might justly point to this report as containing the credentials of the subject for the honor.

The Money Value of Technical Training.

Mr. James M. Dodge, in his presidential address at the recent meeting of the American Society of Mechanical Engineers, took as a text "The Money Value of Technical Training." For convenience of comparison he outlined the actual progress made by four groups of men working in the mechanic arts—the unskilled labor group, the shop-trained or apprentice group, the trade school group and the technical school group. The wages received by each during different periods is capitalized on the basis of 5 per cent., and the result plotted in the form of curves.

The laborer reaches the maximum, corresponding to a capitalized value of $10,200, at the age of twenty-two, his line thereafter remaining horizontal. The apprentice entering the machine shop at the age of sixteen represents a capitalized labor value of $3,000 at starting, which amount increases to $9,000 at the age of twenty and $13,200 at the age of twenty-one and a half years. His line then deflects toward the horizontal and at the age of twenty-five the potential value becomes $15,800, at which the line has already become horizontal. Observations show that 5 per cent. of the apprentices acquiring a machinist's trade rise above this line of the average man, while 35 per cent. follow the line closely; during the period of training 20 per cent. leave of their own accord to work in other shops and 40 per cent. are found unworthy or incompetent and probably never rise to the $15,800 line.

The trade school man enters the machine shop at the age of nineteen, when he can demand a salary of $12 a week, equal to that of the apprentice at twenty-one years of age, and he very frequently makes his employment profitable to his employer. The three years in school have increased his potential value from $3,000 to $12,000, a gain of $9,000. He has thus caught up with the apprentice entering the shop at sixteen and who has been working for five years. By the time the regular apprentice is earning $15.80 per week, the trade school graduate is getting $20 with a potential value of $20,000, or $4,200 greater than that of the shop-trained man. The trade school line continues at substantially the same angle up to an earning capacity corresponding to a potential value of $22,000, when it tends toward the horizontal.

The technical graduate at twenty-two years of age receives a starting wage of $13 per week, or the same amount earned by the regular apprentice at the age of twenty-one and a half, and by the trade school graduate at the age of nineteen and a half. However, the regular apprentice is overtaken in six months and the technical graduate reaches the maximum of the apprentice class pay nearly one year before the latter. Progress continues and the line of the technical graduate crosses the line of the trade school graduate in three years' time, and then continues to diverge from the latter with an earning capacity regularly increasing and a corresponding augmentation of potential or invested value until at the age of thirty-two, or ten years after entering upon practical work, his potential value is $42,000. In other words, six years of preparation have enabled the technical graduate to distance the shop-trained man and the trade school graduate overwhelmingly.

The reason that higher education, other things being equal, carries with it the ability to earn high wages is that, consciously or unconsciously, these men are directing and making it possible for a large number of laborers, shop-trained men and trade school graduates to perform useful work. For this ability and knowledge the technical man receives his pay. Apprentices have made and will make in rare instances a better showing than the average technical man, and many of our greatest men have by their sheer force of character, excellence of brain fibre, persistence and self-education, risen to pre-eminent positions independent of all regular systems, and the same is true of the trade school graduate. Mr. Dodge says, however, that he is dealing with the average of each class, taken from actual statistics, with an earnest desire to ascertain the facts without any frequency of mention of the outcome. It may be stated as a truism that every man pays for the amount of bossing he requires and every man's wage increases in proportion to his ability to act as the boss or foreman of himself and others. The highest wages are paid to the man through whose ability the largest number of other men may be most profitably employed. He does his work with his brain. Thus, on the one hand, we see under a slave system manual labor receiving no wages, and on the other mental labor receiving the highest reward. A practical man performs his work within the radius of his arm; a technical man within the radius of his brain. This fact is, however, even to-day, realized by a few, and it is gratifying to know that the number is increasing.

Mr. Dodge, in his address, also considered the value of technical training in the organization and management of manufacturing plants and enterprises and a time not very far distant when it will be almost universally recognized that establishments should be trained as well as individuals, and that the marvelous development in scientific shop practice and management will do for the manufacturer fully as much as technical training is doing for the individual.

Actinium and American Radium.

Sir William Ramsay is reported to have said in his recent lecture that American radium has no radioactivity. This is contradicted by authorities in this country. Prof. Alexander Hamilton Phillips, professor of chemistry at Princeton University, has examined a quantity of carnotite, an ore of uranium, which is being mined by the Welsh-Lofftus Uranium Company, of Buffalo, which is at present endeavoring to furnish radium from an American ore. Prof. Phillips analyzed twenty-five pounds of the Colorado mineral and obtained from it one gram of radium-barium chloride of an activity of 1,500. He made photographs of keys and other objects, proving its actinic properties. The radioactivity was finally determined by Prof. Adams, of the physical department of Princeton, who measured the activity by means of a Wilson gold leaf electrometer, and also with the pith balls, there being no doubt as to the activity being quite 1,500. Prof. Phillips also stated that some of the radium said to have been extracted by the Buffalo people was not radioactive, due possibly to the fact that the radioactivity was lost in the chemical operations.

Dr. George F. Kunz states that he himself had been able to cause phosphorescence in a 15-karat diamond by means of a recent sample received from the Welsh-Lofftus Company. On the other hand, some of the Buffalo radium recently tested at Columbia University showed no radioactivity.

In this connection, Dr. Kunz makes an interesting statement with regard to some actinium recently received here, and says: "This actinium was a preparation of the oxide, with an activity of 10,000 (uranium being taken as unity), prepared by Dr. Debierne and sent to me through the courtesy of. Prof. P. Curie. The emanations from it seemed most profuse, and although it had been exposed for two weeks in a paper package, yet they were as energetic at the time of its arrival and one week after as they could have been at any time. The substance is wonderfully radioactive. In the few experiments that I have made upon it I found that, like radium, it causes the diamond to phosphoresce, and exerts the same action as radium upon willemite and kunzite, with the possible exception that the emanations from the small quantity of the substance seemed to become luminous before they touched the willemite itself. The surface affected measured two square inches, many times the surface of the actinium. The effect produced on willemite was somewhat different from that due to radium. The luminescence apparently penetrated the willemite, and at the same time it almost seemed as if a luminous emanation left the material. It was also found, on applying some powdered and granulated willemite to the inside of a closed jar twelve centimeters high, and placing this over the actinium, which was in a paper, that the emanations made luminous the entire interior of the jar. On the other hand, they do not appear to possess the penetrating power through glass that the radium compounds show, for in the same experiment they failed to affect the willemite on the outside of the jar, although the glass was only one and one-half millimeters in thickness. A platinum-barium-cyanide screen immediately responded when the actinium was held against the black paper on the back. The abundance of emanations from the substance, rather than their penetrative quality, seemed to be its characteristic. One of the properties of actinium which Prof. Curie mentions in his letters is the emission of many emanations which last for some minutes. This feature of endurance was not observed. On the other hand, a peculiarity of actinium, as compared with radium, is that the emanations, although more profuse, disappear in a few seconds. Another marked feature is a certain visibility or materiality of the emanations. This has already been referred to in some of the experiments above described in connection with willemite. If actinium is placed in a paper over a screen of the phosphorescent sulphide of zinc (Sidot's blende), the screen will become illuminated, and on slightly blowing, so as to produce a current of air, the light is carried along the screen with the emanations."

Interstate Independent Telephone Convention in Chicago, December 8, 9 and 10.

(*By Special Telegrams to* ELECTRICAL WORLD AND ENGINEER.)

IN accordance with the announced programme, the Interstate Independent Telephone Association began its convention on Tuesday, December 8, at the Auditorium, Chicago. The first session began in the afternoon and was called to order by Mr. C. E. Hull, president, of Salem, Ill. There was a large attendance. The Mayor, Mr. Harrison, sent an official representative, who welcomed the convention to Chicago because it represented the independent element in the industry, and who called attention to the fact that for the first time one could now call up the Mayor and the police department by independent telephone in Chicago.

A committee was appointed to draw up resolutions of regret in regard to the late H. C. Rainey.

President Hull then delivered an interesting address. He congratulated the members on meeting again in the city that saw the birth of the Association. He urged as important matters demanding attention the revision of the constitution, the establishment of permanent headquarters, standing committees, and in general a more closely knit organization.

Secretary Coleman's report stated that this year the telephone manufacturers had abandoned the customary entertainment and the Association committee had, therefore, itself taken the matter in hand and arranged for that feature. He gave statistics for the industry, stating that the investment of the subsidiary Bell telephone companies was $373,585,609, and of the long-distance system $28,000,000 in bonds and $131,628,000 in stock. There were 1,277,983 Bell subscribers, giving a capital per subscriber of $417. For the independent investment he claimed 2,000,000 subscribers and 200,000,000, or only $100 per subscriber, as capitalization. Iowa was the banner independent State, with 1,200 companies. Mr. Coleman said that in the past sympathetic public sentiment against the "Bell monopoly" had worked wonders for the independents; but now something more than that was needed to sustain the independent spirit and insure growth. Years ago the Bell tactics and plan of campaign had been to buy up independent exchanges, later to buy important centers, later to control toll lines, and last of all to get control of large manufacturers of telephone apparatus. He held that some plan to bring members of the Association into more compact business relations should be put into operation at once. Enthusiasm, while important, would not make a solid and enduring organization. There must be a movement started for more thorough business co-operation. Bureaus for patent protection, general information and standardization were strongly urged and the finances of the Association should be so arranged as to permit the entire time of a competent man being given to the conduct of a permanent office.

A committee of nine, one from each State, was appointed to consider the secretary's report and draw up a new constitution embodying these suggestions. It consisted as follows: Indiana, H. A. Barnhart; Iowa, J. S. Bellamy; Ohio, W. Gay Jones; Illinois, C. B. Cheadle; Minnesota, E. H. Moulton; Kentucky, Mr. Matthews; Michigan, C. E. Marsh; Missouri, J. M. Kennedy; Wisconsin, W. F. Goodrich; President Hull, ex-officio.

Prof. W. E. Goldsborough, of the electrical department of the St. Louis Exposition, invited the next convention to the fair, and outlined the plans of other electrical bodies and of the International Electrical Congress.

A special committee consisting of L. A. Frazee, C. M. Bandy and W. Gilford Thompson was appointed to learn the prospects of independent telephone toll connection with Chicago over the automatic exchange circuits of the Illinois Telephone Company, and to ask President Wheeler of that company to appear before the body in order to make a statement on the subject and the prospects.

The convention was invited to visit the Illinois Automatic Exchange Works. No session was held on Wednesday forenoon.

At the session on Wednesday afternoon the committee appointed to confer with the Illinois Telephone Company reported the results of its visit to President Wheeler, who had stated that the company in the spring would begin trunk lines to the outskirts of the city from its central automatic exchange. When these were completed it would take up the matter of toll connections with any company having good circuits and apparatus. As soon as ready the company would be anxious to connect with outside companies, but it was not ready at the present time.

The classification of freight rates was briefly discussed by the convention. It was shown that dry batteries now pay at the same rate as wet, but it was naturally held that they should not do so, as they were not so breakable and were, therefore, easier of transportation by the railroads.

A discussion arises on the question whether companies having toll connections over Bell telephone lines should be admitted to membership. This important topic which has already been before the association, brought on a very lengthy and animated discussion, but nothing definite was done, and the question was finally referred to the committee on credentials. The committee which had been appointed on reorganization reported that the present constitution and by-laws were inadequate. It recommended that pending a complete revision of the constitution making sweeping changes, a temporary constitution be enacted and that the association should be incorporated without capital with $5 dues and an additional tax if and when necessary. It was also recommended that there should be uniform toll line contracts between members and uniform exchange rates based upon the number of telephones in operation. Messrs. Hull, Rex, Coleman and Barnhart were recommended as a permanent committee to effect plans for carrying out the organization.

A very interesting paper was then read by the secretary from Prof. J. C. Kelsey, of Purdue University, on the subject of "The Standardization of Telephone Apparatus," and a paper was also presented by W. C. Polk, of Kansas City, on "The Standardization of Telephone Construction." With regard to the suggestions presented involving the adoption of standard specifications and the advocacy of a board of engineers to advise regarding apparatus and methods of construction, it was stated that the reorganization committee was considering the establishment of a board of engineers to work out such standard specifications as would enable good long-distance toll service between various independent companies. Both papers were referred to the reorganization committee. The two papers were both discussed at considerable length, the variety of practice in the independent field presenting innumerable points of view on the various questions involved.

Mr. H. D. Critchfield, formerly of Cleveland, and well known as one of the pioneers in the independent ranks, appeared before the

convention as representing the Illinois Telephone Company, with which he has been connected for some time past. He gave an outline of the work that has been done in connection with the enterprise known as the Automatic Chicago Exchange, details of which have already been given in ELECTRICAL WORLD AND ENGINEER. He said that 21 miles of tunnel were completed in the Loop district for telephone cables, freight and other public utilities. He also stated that the stockholders of the Illinois company controlled absolutely the Automatic Electric Company, building what was formerly known as the Strowger apparatus, so that customers were absolutely insured a supply of apparatus. In the spring, as had already been intimated, the company would build toll lines out into the surrounding country and connect with other independent companies. Mr. Critchfield insisted, however, that such companies desiring connection with Chicago must have first-class apparatus and equipment. No toll service would be given into Chicago until good service has been assured. When questioned upon the subject, Mr. Critchfield stated that the Illinois Telephone Company was absolutely independent of the Bell. Its plans were for 92 miles of tunnel ultimately. The present exchange was in a temporary building, but the permanent new exchange building would be put up on ground which would be vacant next spring. Probably toll line connections would be ready for service into Chicago next fall.

The paper of Mr. H. A. Barnhart, of Rochester, Ind., to be presented on Thursday, is more or less of an attack on the Bell organization, and states that independents cannot hope to compete or cope with the centralized Bell power if the independent business continued to be carried along on the ancient loose-jointed method of everyone for pimself. Mr. O. Rex, of North Manchester, Ind., presented a short paper without any very specific ideas or recommendations on "Competition Between Independent Companies and Farmers' Mutuals." He advises a friendly attitude toward the mutuals and suggested aiding them with helpful suggestions in regard to their work.

Mr. Prewitt, of Winchester, Ky., presents a paper outlining a political scheme of organization for independent telephonists. He advocates dividing the country into telephone districts disregarding State lines, taking the larger cities as centers, including the territory that is tributary from a telephone standpoint. He would organize each district into an association. The National organization should include a Senate and a House of Representatives, and each local company should have representation in both.

At the Thursday session the report of the nominating committee was adopted and the following officers were elected: H. A. Barnhart, Rochester, Ind., president; E. H. Multon, Minneapolis, vice-president; E. H. Coleman, Louisville, Ky., secretary; A. B. Conklin, Aurora, Ill., treasurer. Executive Committee—C. E. Hull, J. S. Bellamy, O. Rex, R. Valentine, W. G. Jones, H. G. Conger, W. Matthews, C. E. Wells and J. G. Splane. There was no meeting in the afternoon, but a banquet in the evening. (Special dispatches giving details of exhibits will be found on page 976.)

STANDARDIZATION OF APPARATUS.

Prof. J. C. Kelsey, of Purdue University, read an interesting paper entitled "Standardization of Apparatus." After showing how steam railroads, owing to interchange of traffic, were compelled to standardize their equipment, and how a similar condition was brought about in the case of telegraph companies, he said that telephone systems are naturally sure to encounter the same situation. The telephone subscriber is no longer confined to a limited district, and since he may desire to talk to a neighbor one mile or four miles, or one thousand miles distant, there is a growing necessity for a standard system whereby any through connection can be made, with efficient apparatus at both sending and receiving ends.

Experience has already decided the gauge of the telephone transportation track. It is a metallic line, composed of No. 8 B.W.G. copper wires. Whatever the locality its characteristics are in general the same. It is a well-known fact that this line must be transposed and well-balanced to be quiet under all disturbing conditions. If of considerable length, it becomes very sensitive to unbalances, and upon connection with a local exchange subscriber will quickly prove the unbalanced condition of the local switching apparatus, which would never be disclosed by a short toll line, or a purely local line. But if this toll line extends into territory where trolley wires, high-tension and electric light wires abound, it developed still more decided characteristics. It becomes supersensitive, and may be said to be looking for trouble. The unbalance that the long unexposed toll line would not detect will now be disclosed by a roar so great as to forbid conversation.

As the interurban lines, with their accompanying high-tension wires, invade the country, every exchange operator will inevitably experience this changed condition of his toll lines. His local lines and switching apparatus, which once gave him good toll service, will be rendered comparatively useless, as the oversensitive toll line will not permit of the least unbalance. If this oversensitive line connects with an exchange using series drops in circuit, the connection will be too noisy for use. If it connects with a common return system, great noise will result. If it connects with a metallic exchange, with lines having bad joints and careless structure, the connection will also be too noisy for use. If it connects with a well-balanced metallic system, using cheap, or poorly-designed transmitters, poor transmission will result. If it connects with a common battery system, using twenty volts battery pressure, the connection is noisy, and the signals are rendered inoperative. The same condition will apply to the forty-volt common battery system. Therefore, in view of the great number of independent exchanges, it is not likely that every exchange owner will consent to the making of radical changes. He will consent to any moderate change that will ameliorate conditions, and, luckily, the repeating coil, if properly designed, will accomplish the result.

General standardization does not mean that each and every system shall be manufactured by the same company. Every company can manufacture standard drops, relays, ringers, generators and other devices. A standardized system is one, if applied to local battery, that will operate in direct conductive relation with the standard toll line without the least noise due to unbalance, thereby giving absolute sway to the voice tones. To attain this efficiency, a system would have to have balanced and well-insulated metallic lines, 1,600-ohm bridging bells, 1,000-ohm clearing-out drops, and open-circuit generators. The absence of repeating coils and series apparatus would be quite conspicuous. However, if it is necessary to have a grounded party enter the standard exchange, a suitable repeating coil should be placed in circuit between the terminal arrester and the line jack. As to a suitable repeating coil, there is more difference in repeating coils than in any other telephone apparatus.

A standard common-battery system is one that will give a quiet line connection, and efficient transmission between the long-distance points. But, strange to say, at this very moment, there is an idea gaining ground that common-battery transmission has not come up to standard. As a result, one will find many companies maintaining local battery stations for long-distance service. It is an unfortunate condition, and he was compelled to admit the justification of the idea. The blame does not rest upon the system, because all transmitters have a central source of energy, for no reason can exist why a common-battery transmitter cannot be made just as good as a local battery transmitter. Nor is it a question of battery voltage, for on local service one cannot tell the difference between ten, twenty or forty volts, transmission being satisfactory in all cases.

In explanation, a comparison will be made. It is conceded that a local battery induction coil must have comparatively few turns in the primary, and a great number of turns in the secondary, in order to transmit a small amount of current at a high pressure and avoid the losses which would result from heavier current and low e.m.f. We will all admit that if this induction coil had equal turns on secondary and primary, we could not look for very good results on long-distance service. This is precisely the difficulty the common-battery systems are contending with. They either use repeating coils of equal windings, of no potential raising power, or condensers with the effect exactly the same, and then expect a low e.m.f. to transmit the voice currents to great distances. For the e.m.f. of common-battery voice currents is low, very low, and it is safe to say that it does not exceed the primary voltage of local battery instruments. If it is necessary in local battery practice to raise this low primary voltage to a high secondary voltage, running up into hun-

dreds, why is it not necessary for the common-battery systems to adopt the same practice? Common-battery systems can be easily standardized, and the subscribers deserve it, for they do the bulk of the long-distance business.

Long-distance service has caused the cry for standardization. The American Telephone & Telegraph Company has heeded the cry and is bending great energies toward this necessary state. The independent interests must also heed the cry. They have successfully fought local conditions, and the long-distance field is the battle-ground of to-day. Manufacturer and operator alike must turn from local conditions and look toward their neglected long-distance field. Toll business offers opportunities for revenue that should not be neglected. What operator would refuse to lease each side of his toll line for telegraph purposes at from ten to twenty dollars a year-mile, and still retain the integrity of his telephone privileges? And how many operators know how to accomplish this result, and to what manufacturer of telephone apparatus can they look for reliable information and standard apparatus? Truly, the operator has fought his licensee competitor with great odds against him, as far as a source of knowledge and experience is concerned.

A satisfactory standardization of apparatus can be attained when each and every telephone operator can have the means of finding out what apparatus is standard. The only institutions who have the power to name the standards are the various state, interstate and national associations. Let the Interstate Association take the initiative and name a standardization committee, composed of engineers of various companies, empower them to make tests, and report the same at the next convention, or to encourage the annual meeting of the engineers and traffic managers of the operating companies, the consulting engineers, and engineers of the manufacturing companies, under the auspices of, and at the time of the interstate convention, with plenty of time for papers, reports of tests, discussions and expression of opinion. He believed that meetings of this kind will do more to bring order out of chaos, to establish a uniformity of local and long-distance practice, and bring about a general standardization than any other process. The hope of standardization in independent circles lies in a combination of individual effort on the part of the engineer. Let all companies cheerfully pay his expenses to the annual convention. Results will justify it.

Interurban Electric Traction Systems—Alternating Versus Direct-Current.

BY PAUL M. LINCOLN.

ELECTRIC traction is peculiarly an American institution; that is, it has found its widest application in American communities and has been developed chiefly by American engineers. In America practically every town of over 5,000 inhabitants is provided with an electric traction system. In other parts of the world it is only larger centers of population that are so provided.

Practically all the traction work in America has been done by direct current. The alternating-current traction system, although it has received considerable attention from American engineers, has not until recently been favorably considered by them. In Europe, on the other hand, the alternating-current traction problem has received a large amount of attention. The polyphase induction motor has been developed by European engineers for traction purposes, and a number of installations have been made in Europe with apparatus of this character. American engineers have consistently refused to adopt the polyphase induction motor for traction purposes on the ground that it is not suitable for that purpose. The principal reasons for this stand are two in number:

(1) That the polyphase induction motor is inherently a constant-speed motor, and, therefore, not adapted to traction purposes. Continual change of speed is one of the characteristics of traction work. The direct-current series motor is peculiarly adapted to this class of work because it is inherently a variable-speed motor. At one definite speed the polyphase motor is an efficient machine, while at all other speeds the efficiency cannot be greater than the ratio of the actual speed to the synchronous speed. For instance, if the actual speed at which a given induction motor is working is 10 per cent. of its synchronous speed, the power utilized is at most only 10 per cent. of the power put in. In traction work a large part of the work done is necessarily at speeds below the maximum attained, and at these lower speeds the maximum economy that can be obtained from induction motors is necessarily small.

One expedient used by European engineers to reduce this source of loss is the use of motors in concatenation or in tandem; that is, the secondary of one motor is fed into the primary of another on the same car. If the pair of motors thus concatenated are wound for the same number of poles, this expedient has the effect of making the synchronous speed of each of the pair of concatenated motors one-half that which it is when not in concatenation. It is equivalent in direct-current practice to throwing two shunt motors in series. Up to the half speed point, therefore, there is a gain of economy by this arrangement; by winding the two concatenated motors for different numbers of poles, more than one point of maximum economy can be secured between zero speed and full speed, but this arrangement has the disadvantage of being able to use but one-half the total motor capacity above half speed, while the greatest expenditure of energy takes place above half speed.

In order to secure the advantages of concatenation, however, it is necessary to add largely to the weight of the electrical apparatus. European practice has been to equip cars with four motors, two main motors and two others used only while the car is below half speed. Above half speed the motors are running idle and are doing no useful work. The energy required to take care of the additional weight is an offset against the energy which is saved by concatenating the motors. For long runs this expedient would probably be detrimental, since the energy taken up to transport the extra weight would be more than equivalent to the energy saved at the start.

(2) The second reason against the use of polyphase induction motors for traction purposes is the necessity for providing at least two overhead conductors. If the track is not used as one of the conductors, then the necessity arises of using at least three overhead conductors. Maintenance of insulation on such overhead conductors when they are at high voltage is naturally a difficult problem—much more difficult than to maintain the insulation between a single conductor and ground, as would be the case in the single-phase system.

American engineers, instead of endeavoring to adapt the unsuitable induction motor to traction purpose, have devoted their energies to the development of a suitable alternating-current motor. The idea of using a series motor operated by alternating current is not new. The only alternating-current, single-phase motors which have a characteristic suitable for electric traction purposes are those of the commutator type. In no other type of motor are the speed and torque characteristics such as to be suitable for traction purposes. In the commutator type alternating-current motor, the speed and torque characteristics are practically identical with these characteristics in the direct-current series motor. As early as 1893, extensive experiments were made by the Westinghouse Electric & Manufacturing Company, on this class of motors. In fact, the experiments went so far as the equipment of a car with two motors of this type and the car was put into actual operation. Moreover, the frequency and voltage for which the motors were designed was practically the same as those for which the more recent motors were designed. These early motors were considerably smaller in capacity, however, and the trolley voltage was less. Further, the method of controlling the speed was by control of voltage. Although the early motors were successful as motors, the alternating-current system as a system was not thought at the time of sufficient importance to continue the developments along this line. In other words, the time was not yet ripe for the development of this system. Interurban electric traction work, such as exists to-day, was not at that time thought of, and this is in my opinion the peculiar field for the alternating-current traction system.

In considering the general problem of electric traction, the question naturally arises: What is gained by the use of alternating over direct current? and the converse of this question also naturally arises: What is it necessary to sacrifice in order to obtain the benefit of alternating-current traction? An analysis of the advantages and disadvantages of these two systems may be of interest. Although many of the following points have been treated in previous papers, particularly that of Mr. Lamme before the American Institute of Electrical Engineers, in September, 1902, it is hoped that with a repetition of some of the plans mentioned will be borne.

The principal advantages of alternating-current electric traction over direct current are as follows:

(1) Limits to trolley voltage are removed.
(2) Avoidance of rheostatic losses.
(3) The necessity for rotary converter sub-stations abolished.
(4) Manual attendance at the sub-stations done away with.
(5) Danger of electrolysis by return current avoided.

To take up these points more in detail:

(1) *Voltage Limit Removed.*—The greatest item of cost in the electrical equipment of interurban traction systems as they exist to-day is that of secondary distribution. This item of cost usually carries somewhere between 25 per cent. and 50 per cent. of the total for electrical equipment, and is usually much nearer the latter figure than the former. Six hundred volts at the motor in a direct-current traction system is practically the limit at which present designers and manufacturers are willing to guarantee their operation, except in some special cases. This necessarily limits the voltage fed into the secondary distribution system to, say, 700 as a maximum. The consequence of this comparatively low voltage is naturally a high cost for conductors of this secondary distribution. The alternating-current system, providing as it does the possibility of greatly increasing the voltage of the distributing system, thus cuts down largely the cost of this distributing system.

Another point which militates against the use of direct current is the fact that when large motor units are used it is difficult to collect the great amount of current for their operation. For this reason, as well as an advantage in cost, trolley construction has been largely replaced by the third rail for interurban work. By raising the voltage of the secondary system, the current taken by a locomotive may be reduced, and consequently the difficulty with collecting devices may be made to disappear.

(2) *Rheostatic Losses Avoided.*—In the direct-current system the voltage at the car is practically constant, and while the counter e.m.f. of the motors is building up the excess voltage must be taken up by resistance. At the start, therefore, a comparatively large rheostatic loss occurs. With the alternating-current system, on the other hand, the voltage at the car may be controlled by suitable means and the rheostatic loss thus avoided. When stops are few and consequently runs are long, the rheostatic loss in the direct-current system is a small proportion of the total, and, therefore, under these conditions this advantage of the alternating-current system is not so greatly marked. With short runs, on the other hand, and consequently frequent starts, the rheostatic loss with the direct-current system amounts to a considerably greater proportion of the total loss and the alternating-current system, therefore, can have the greater advantage.

Figs. 1 and 2 show the superposed kilowatt curves for a car equipped in one case with direct-current motors and in the other with alternating-current motors. The weight of the direct-current car is 35 tons and of the alternating-current car about 18 per cent. greater. The length of run is two miles in each case, and the schedule speed 30 miles per hour. Were it not for the saving of rheostatic loss, one would expect that the alternating-current equipment being 18 per cent. heavier would take 18 per cent. more power. The actual difference in the areas under the curves, however, shows about 10 per cent. more power in the alternating current than the direct current on account of avoiding rheostatic loss in the alternating-current equipment. If the run were for about one mile instead of two, the consumption of power would be about equal, and for runs of less than one mile the alternating-current power consumption would be less.

(3) *Necessity for Rotary Converters Avoided.*—The cost of sub-station equipment constitutes one of the large items in the cost of the electrical equipment of an interurban road. In this sub-station equipment by far the largest item of cost is the rotary converter. In the alternating-current equipment the rotary converter has no place, thus avoiding not only a large item of cost, but also one of the largest items of the loss of power.

(4) *Attendance at Sub-Stations Done Away with.*—The direct-current rotary being a piece of revolving machinery, of course requires manual attendance at the various sub-stations. Alternating-current sub-stations consists of transformers only, and therefore require attendance only for the purpose of operating the switches. Making the switching devices entirely automatic in their operation avoids the necessity of attendance for this purpose. A still further refinement is the use of distant controlled switches operated from a central point, say the main power house. Electrically-operated switches have already been developed to be operated from a distance of several hundred feet, and no reason exists why this distance of operation cannot be extended to 20 to 30 miles by proper design. By including in such a switch-operating mechanism also a signalling device, by which the position of the switch is made known at the central point, the switch-operating system becomes complete, and no necessity exists for attendance at the alternating-current sub-stations for any purpose except occasional inspection. There is, of course, an expense in connection with installing such a system of operating switches electrically, but it bears no comparison to the expense of manual attendance.

(5) *Electrolysis.*—Electrolysis of parallel conducting systems is generally recognized as one of the most serious dangers in connection with present direct-current trolley systems, and the fact that an alternating-current system avoids this danger entirely need only be mentioned in order to be recognized as a marked advantage.

So much for the advantages which accrue to the alternating-current system. Now the question arises: What points must be sacrificed in order to obtain these advantages. The disadvantages which necessarily accompany the use of the alternating-current traction system are as follows:

(1) Additional weight.
(2) Difficulty of operating on existing lines.
(3) Increased rail loss.
(4) The fact that an active e.m.f. exists between field turns.
(5) Possible interference with telephones.

Now suppose we take up the above points in detail.

(1) *Additional Weight.*—An alternating-current motor of a given capacity is necessarily somewhat heavier and somewhat more expensive than a direct-current motor for the same capacity. This difference in the motor, however, does not constitute the total difference in weights of equipment. In order to make use of the advantages of high trolley voltage, the alternating-current equipment should preferably be provided with a step-down transformer on the car. Also, in order to obtain the advantages of avoiding the rheostatic losses, some provision must be made for controlling the voltage on the car. The transformer, the voltage-control apparatus, and the greater

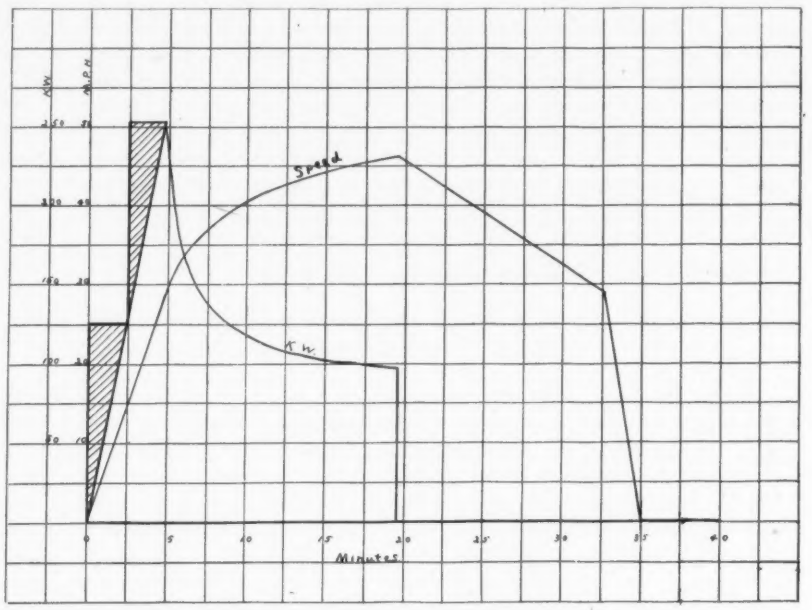


FIG. 1.

weight of motors make the alternating-current equipment necessarily heavier than the direct current. Although this difference need not, and in many cases will not, be as great, the example cited later in this paper (18 per cent.), still a difference in weight will always exist detrimental to the alternating-current equipment. This greater weight of the alternating-current equipment is one of the items on the debit side of the ledger.

One of the most attractive methods for controlling the voltage on the motors is the use of an induction regulator. The principal advantage over other forms is that it does not require the interruption of the current and is, therefore, of particular advantage in large equipments. It is this problem of breaking the current that forms not only the greatest difficulty with direct-current equipments of large capacity, but also one of the largest items in the deterioration account. The induction regulator has the disadvantage of adding considerably to the weight, and in equipments of comparatively small size where the difficulty of current interruption is not great, will probably be replaced by some other method of voltage control, such as loops or commutated coils on the car step-down transformers.

(2) *Difficulty of Operating on Existing Lines.*—Practically all interurban roads run in and through cities on existing tracks and therefore must use the existing sources of direct-current power. In order to meet this condition, the equipment for an alternating-current interurban road must be so arranged as to operate on alternating

current outside the city and on direct current inside. Although this is entirely possible, it must necessarily prove to be a matter of considerable complication. It means in the first place the use of motors which can be operated by both direct and alternating current. This is entirely possible with the series alternating-current motor. It means in the second place that another system of control must be added to the car. This objection might, in part, be avoided by using rheostatic control for both the alternating-current and direct-current conditions, but the objection obtains that this method will deprive the alternating-current system of its advantages of saving rheostatic losses. Further, means will have to be provided for disconnecting all transformers when running from a direct-current system and reconnecting them when running from an alternating-current system. All these matters, although they mean a considerable amount of complication, are entirely possible. The most important part of the equipment—the motors—can be operated by direct as well as by alternating current.

(3) *Increased Rail Loss.*—Experiments have shown that with alternating current from 2,000 to 3,000 alternations, the actual loss which takes place with a given current through the iron rails is from three to five times that which the same direct current would give. The higher ratios of loss hold for the higher frequencies. At first thought this seems to be an important objection to the alternating-current system. But when it is considered that in order to utilize the main benefit of the alternating current, a higher trolley voltage is used and, therefore, smaller currents in the return conductor, the element of rail loss in an alternating-current proposition may be made even a smaller proportion of the total than in the direct current, in spite of this apparently large handicap. The rail loss with direct current is usually a small proportion of the total, and this with alternating current, at the trolley voltages which are usually considered, viz.:

(4) *Active E.M.F. Between Field Turns.*—The space that can be assigned to the motor for operating a car is necessarily limited. It is this limitation of space, in fact, which often forces the use of a four-motor equipment instead of a two-motor equipment, the available space not being large enough to allow the installation of motors, two of which are sufficient for the work. When we consider the alternating-current motor, the question of space available becomes still more exacting, first because the motor is necessarily heavier and, therefore, occupies more space than an equivalent direct-current motor; and, second, because of the active e.m.f. that exists between the field turns in the former and which, other things being equal, again requires additional space for insulation. In the matter of e.m.f. between field turns, the alternating and direct-current motors are quite different. The e.m.f. between the field turns of a direct-current motor is due simply to ohmic resistance, and a short-circuit between turns simply throws out of action the turns so short-circuited, and if not too severe, does not interfere seriously with the motor's operation. Between field turns of the alternating-current motor, on the other hand, there is an active e.m.f. similar to that between the turns of a transformer winding. A short-circuit between field turns in this motor, therefore, means a destructive short-circuit and an immediate interruption of a service from that motor. In other words, the effect of a short-circuit between field turns in an alternating-current motor has the same effect that a short-circuit between armature turns would have in either the alternating or direct-current motor. Roasting out of field coils is one of the most frequent causes of trouble in direct-current motor equipments, and it is realized that this matter of active e.m.f. between field turns in the alternating-current motor is a serious one. As an offset against this disadvantage of an active e.m.f. between field turns, the alternating-current motor possesses the advantage of being capable of operation at low voltage, thereby reducing the number of turns on the series field and increasing the proportionate space for insulation. The use of a step-down transformer on the car makes available any desired voltage at the motor. This existence of an active e.m.f. between field turns is the most serious obstacle to the use of high voltage on the motor. Even with low voltage, the alternating-current motor is laboring against the handicap of occupying more space than an equivalent direct-current motor, and the use of high voltage still further increases this handicap. The limitations of space do not apply to the transformer in anything like the same degree that they do to the motor, and no particular difficulty is anticipated in building a transformer for this work.

This limitation of available space for the motor and the existence of an active e.m.f. between field turns make it seem probable to the writer that the alternating-current railway motor of the future will be operated at low voltage and will receive its current from a transformer situated on the car.

(5) *Interference with Telephones.*—It is a question whether alternating current in the rails will interfere with telephones and similar instruments more than the direct current which they have to contend with at present. In any event, the amount of current in the rails can be reduced by the use of higher voltages so that this source of interference can be made less than it is with the present direct-current system. Further, means have been proposed whereby the current can be confined entirely to separate conductors provided for the purpose and not allowed to wander at will through any return circuit that may exist, as is the case with the direct-current system. This can be done, of course, only at the expense of erecting a separate system for the return currents and a system of series transformers whereby these currents can be confined to this return system. The alternating-current system therefore possesses the advantage of being able to use the rails for contact and still not allowing the alternating currents to escape at will through the earth. As a matter of fact, interference with other circuits by the alternating-current system is expected to be less than with the present direct-current system.

The engineer has been defined as a man who could do for one dollar what any fool could do for two. The engineer, in other words, stands for efficiency. It is he who accomplishes a given result with a minimum expenditure of effort and money. Suppose we apply this criterion to the comparison between alternating and direct-current systems: By which of these systems can a given service be rendered most economically? In order to answer this queestion, we shall assume a certain typical interurban road, ascertain the first

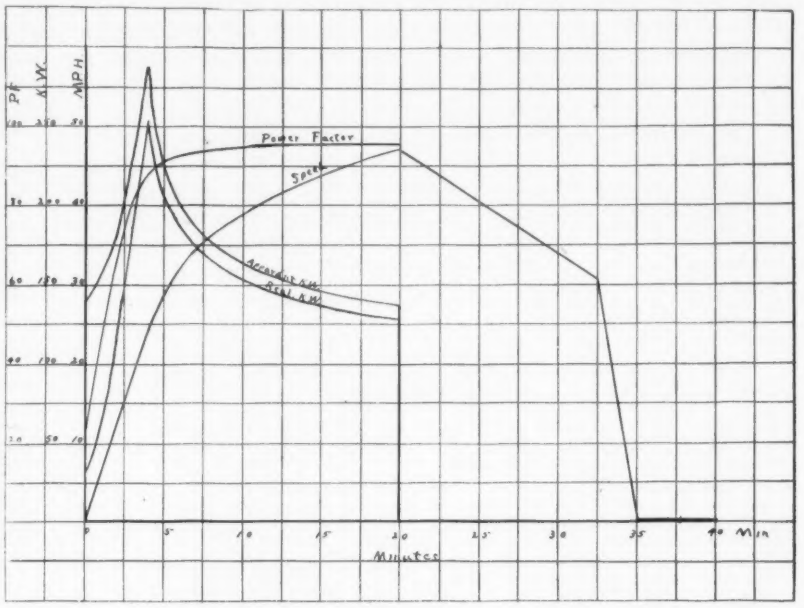


FIG. 2.

cost by both systems and the cost of operating by both systems and compare the results. Suppose the typical road which we will assume to be as follows:

Length	60 miles.
Schedule speed	30 miles per hour.
Cars running half hour apart:	
Number of stops (that is runs 2 miles long)	30
Weight of direct-current car, complete	35 tons
Weight of alternating-current car, complete	41.3 tons

It may be noted here that the above difference in weight is not the minimum that can be obtained. A large part of the difference in weight comes, as previously stated, in the induction regulator, with which it is assumed the alternating car is equipped. Other methods of voltage control can be supplied which would be considerably lighter, but the induction regulator is selected on account of the advantages previously mentioned. The alternating-current system is, therefore, working under a handicap which is greater than would be the case if some other method of control were assumed.

Fig. 1 shows the speed-time and kw. hours curve of a direct-current car of 35 tons over the typical run. The equipment, gear ratio, acceleration, etc., are as follows:

Weight of car, 35 tons; equipment, two No. 50 C. Ry. motors; schedule speed, 30 miles per hour; average volts at motors, 550;

braking accel., 2 m. p. h. p. s.; average kw., 67.2; mean 2 current per motor, 105 amp.; acceleration, 1.0 m. p. h. p. s.; gear ratio, 21:50; wheels, 36 in.; run, 2 miles; stop, 30 sec.

Fig. 2 shows the same for an alternating-current typical run, and in addition gives also the apparent kilowatts and power factor. Following are the data of this car: Weight, 41.3 tons; equipment, two 175 hp. ac. motors; gear ratio, 17:53; schedule speed, 30 miles per hour; stop, 30 sec.; braking accel., 2 m. p. h. p. s.; average kw., 73.9 real, 84.7 apparent; accl., 1.0 m. p. h. p. s.; wheels, 36 in.; run, 2 miles; average volts at motor, 200.

It will be noted that the difference in power at the car is only 10 per cent. in favor of the direct-current equipment in spite of the fact that the difference in weight is 18 per cent in favor.

The location of the power house is assumed in both cases to be on the line of the road midway between the termini, therefore 30 miles from each terminus. In each case also one of the sub-stations is located in the power house. In the alternating-current proposition the generators are wound for trolley voltage (3,000 volts) and feed directly into the trolley.

In each case also there are supposed to be four feeding points beside the power house, thus making the sub-stations 12 miles apart in both cases. Further, in both cases the secondary system is a single network thus gaining the advantage of two feeding points except beyond the end sub-stations. In neither system are secondary feeders figured on, the alternating-current being simply a 4-0 trolley wire throughout, and the direct-current a 60-pound conductor rail. In the latter system the high-tension line is supposed to be along the right of way of the road and the high-tension poles are utilized for supporting the trolley wire with a bracket construction. Recognition of the fact that the alternating-current car is the heavier and requires more energy is made and larger motors than on the direct-current car estimated on. In the direct-current proposition the generators, transmission line, etc., are supposed to be three-phase, naturally making necessary smaller transformers than in the single-phase system.

The following parallel columns give complete comparison of the power consumption, the losses in the various transmissions and transformations, the first cost of the apparatus used and an estimate of the operating expenses. The conditions are taken as nearly as possible to those in the typical road. Location will, of course, make differences in many of the items considered, but especially care has been used in estimating those items in which the two systems present a difference.

DIRECT-CURRENT RAILWAY SYSTEM.		ALTERNATING-CURRENT RAILWAY SYSTEM.	
POWER REQUIREMENTS.			
Average K.W. at car in typical 2-mile run (fig. 1)	67.2 K.W.	Average real K.W. at car in typical 2-mile run (Fig. 2)	73.9 K.W.
No. cars running at one time	8	No. cars running at one time	8
No. sub-stations	5	No. sub-stations	5
Average No. cars per sub-station	1.6	Average No. cars per sub-station	1.6
Mean 2 amps. per car	185.3	Mean 2 apparent K.W. per car	129.0
		Mean 2 amps. per car (3,000 volts)	43.0
Mean 2 amps. per sub-station $= m$	279.0	Mean 2 amps. per sub-station $= m$	68.8
With sub-stations 12 miles apart, 80 lbs. track rail and 60 lb. 3rd rail, resistance between adjacent sub-stations is $= r$	0.90 ohms	With sub-stations 12 miles apart 80 lbs. track rail and No. 0000 trolley resistance between sub-stations allowing for increased rail resistance.	4.2 ohms
D.C. line loss per sub-station $\frac{r m^3}{6} =$	16.1 K.W.	Trolley and rail loss per sub-station $= \frac{r m_2}{6} =$	3.32 K.W.
Average K.W. per sub-station at cars $= 67.2 \times 1.6 =$	107.5	Average real K.W. per sub-station at cars $= 73.9 \times 1.6 =$	118.0
Average K.W. per sub-station at sub-station	123.6 K.W.	Average real K.W. per sub-station at sub-station	121.32 K.W.
Per cent loss in 3rd rail	15.5%	Per cent loss in regulator and car transformer	5.0%
		Per cent loss in trolley and rails	2.8%
Per cent loss in step-down transformers	3.5%	Per cent lost in step-down transformers	3.5%
Per cent loss in rotaries	10 %	Per cent loss in high tension line	2.5%
Per cent loss in high tension line	2.5%	Per cent loss in step-up transformers	3.5%
Per cent loss in step-up transformers	3.5%	Total percentage loss	18.4%
Total percentage loss from cars to P.H.	39.5%		
Average K.W. consumed by 8 cars at the cars	537 K.W.	Average real K.W. consumed by 8 cars at the cars	591 K.W.
Average K.W. at power house for 8 cars	750 K.W.	Average real K.W. at power house for 8 cars	700 K.W.
		Average apparent K.W. at power house, about	825 K.W.
Max. load per sub-station—worst condition 2 cars starting	560 K.W.	Max. load per sub-station—worst condition, 2 cars starting (say 275 apparent K.W. each)	550 K.W.
One 400 K.W. rotary will take care of this 40% overload.		One 350 K.W. transformer will take care of this with 50% overload.	
Average load on rotary	30%	Average load on sub-station, about	40%
Rotary sub-stations are of sufficient size so that one can be cut out temporarily.		These transformers are sufficiently large to take care of road if one is cut out.	
Max. load on power house say	1200 K.W.	Max. load on power house in apparent K.W., say	1400 K.W.
Can be taken care of with three 400 K.W. generators—one for spare.		Can be taken care of with three 450 K.W. generators—one for spare.	
STEP-UP TRANSFORMERS			
Seven 150 K.W. transformers—1 for spare.		Three 400 K.W. transformers—Load can be carried by 2 in case of emergency.	
HIGH TENSION LINE.			
One No. 6 B. & S. gauge line each way from power house 20,000 volt, 3-ph.		One No. 3 B. & S. gauge line each way from power house, 20,000 volt, 2-phase.	
Max. loss, about	8.25%	Max. loss, about	8.2%
Aver. loss, about	2.50%	Aver. loss, about	2.7%
SUB-STATION EQUIPMENT.			
Five sub-stations in all—one in power-house.		4 sub-stations—power house feeds directly into 300-volt trolley.	
Each of four sub-stations to contain:		Each sub-station to contain:	
Three 135-K.W. step-down transformers.		One 350 K.W. transformers.	
One 400-K.W. rotary converter.			
Switchboard.		Switchboard.	
Step-down transformers omitted in power house sub-station.			
LOW TENSION DISTRIBUTING SYSTEM.			
Entire length of track equipped with 60 lb. conductor rail.		Entire length of track equipped with No. 0000 B. & S. gauge trolley.	
CAR EQUIPMENTS.			
Each car equipped with two 150 H.P., D.C. railway motors and multiple control apparatus complete.		Each car equipped with two 165-H.P., A.C. railway motors with multiple control apparatus complete.	
ESTIMATED FIRST COST OF ELECTRICAL EQUIPMENT.			
POWER STATION:			
Three 400 K.W. 25 cycle, 360 V., 3-ph., A.C. gens., at $6,500 each	$19,500	Three 450 K.W., 25 cycle, 3000 V., 1-ph., 2000 alt. gens. at $7,000 each	$21,000
Seven 150 K.W., 350 to 20000 V., self-cooling, oil-insulated trans., 25-cycle, at $1,225	8,575	Three 400 K.W., 17-cycle, 3000 to 20000 V., O.I.S.C. trans. at $2,500	7,500
Switchboard	4,500	Switchboard	3,800
	$32,575		$32,300
HIGH TENSION LINE.			
48 miles of 20000 V., 3-ph. transmission line—No. 6 B. & S. gauge conductors at $900 per mile	$43,200	48 miles of 20000 V., 1-ph., transmission line—No. 3 B. & S. gauge conductors at $1,200 per mile	$57,600
Lightning protection	2,500	Lightning protection	2,000
	$45,700		$59,600
SUB-STATIONS.			
12 135-K.W., 20000 & 360 V., 25 cycle, O.I.S.C. transformers, at $1,175 each	$14,100	4 350-K.W., 2000 alt., 2000 to 3000 V., O.I.S.C. transformers at $2,200 each	$8,800
5 400-K.W., 600 V., 25 cycle rotary converters, at $5,200 each	26,000	5 switchboards at $1,500 each	7,500
5 switchboards at $2,800 each	14,000	Auxiliary signaling lines for operating sub-station switches	7,500
	$54,100		$23,800
LOW TENSION DISTRIBUTION SYSTEM.			
63 miles of 60 lb. conducting rail at $2,500 per mile installed	$157,500	63 miles of No. 0000 trolley wire in place at $900 per mile	$56,700
Bonding main track—63 miles at $400 per mile	25,200	Bonding main track 63 miles at $400 per mile	25,200
	$182,700	15 miles of pole construction, not including H.P. lines, at $630 per mile	9,400
			$71,300
CAR EQUIPMENT.			
12 D.C. car equipments complete, consisting of 2 No. 50-C motors, with multiple control outfit, heaters and contact shoes, at $5,217 each	$62,604	12 A.C. car equipments complete, consisting of 2 165 H.P. motors, with multiple control outfit, heaters and trolley at $8,482 each	$101,774
Total first cost electrical equipment	$377,179	Total first cost electrical equipment	$308,774
ESTIMATE OF YEARLY OPERATING EXPENSES.			
Direct-current System.		*Alternating-current System.*	
5 men at power house—2 shifts, aver. wage $900 per year	$9,000	5 men at Power house—2 shifts—aver. wage $900 per year each	$9,000
1 man at each of 4 sub-stations—2 shifts—at $900 per year each	7,200		
Fuel, water, oil, etc., at ½c. per K.W.-hour, 4,890,000 K.W. hp.	24,450	Fuel, water, oil, etc., at ½c. per K.W.-hour	23,050
Repairs and maintenance of power house (3% of cost		Repairs and maintenance or power house (3% of cost)	969

per year)	971		
Repairs and maintenance of H.T. line (5% of cost per year)	2,285	Repairs and maintenance of H. T. lines (5% per year)	2,980
Repairs and maintenance of 3rd rail (1% of cost per year	1,822	Repairs and maintenance of trolley (4% per yr.)	3,652
Repairs and maintenance of car equipments (12% of cost per year)	7,512	Repairs and maintenance of car equipments (10%)	10,177
Total yearly operating expenses	$55,404	Total yearly operating expenses	$51,256

NOTES ON THE ABOVE COMPARISON.

First Cost.—In the first cost of the two systems above compared no allowance is made for the fact that the alternating-current system requires less energy at the power house, and therefore will economize to a considerable extent in both engines and boilers. On account of the greater apparent kilowatts for this system, generators and transformers will be larger in capacity, but the engines and boilers need not be so great in capacity. So far as transformers are concerned, the alternating system has the advantage because it allows the use of considerably larger units than the direct-current, where three-phase transmission is necessary instead of single-phase, as is the case in alternating system. The alternating switchboards also have the advantage in that two switches per panel are required instead of three.

To render a given service over high-tension lines, more copper is required for a single-phase line than for a three-phase line, and this makes the copper for the alternating system somewhat more expensive than for the direct-current system. The largest difference, however, in the high-tension line items comes from the fact that the poles for the high-tension line are spaced sufficiently close to allow the trolley brackets to be supported from the same poles. In the direct-current system, the spacing need be only sufficient for the requirements of the high-tension line alone.

So far as sub-station transformers are concerned, the alternating system has the advantage of single-phase over three-phase in that larger units are used. By far the largest item of saving in sub-station equipment between the two systems is, of course, in the omission of rotary converters in the alternating system.

The greatest difference in first cost of the two systems is, of course, the great difference in the cost of the secondary network. A glance at the comparative values will show that this difference in the case we have considered amounts to nearly $100,000, and is therefore nearly 30 per cent of the total cost of the direct-current system.

In first cost the alternating-car equipments are, of course, considerably higher than the direct current. I would call attention to the fact, however, that the costs of the alternating-car equipment include an induction regulator. If some other style of regulator, such, for instance, as loops on the car transformers, has been figured upon, the cost of the alternating-car equipments might be diminished by something like 5 per cent.; that is, something over $6,000. The saving in weight by the same change and the consequent saving of power in the alternating system would amount to nearly 4 per cent. of that which has been figuring upon. In the item of maintenance of the control apparatus, however, it is believed that the induction regulator has the advantage in that it is not necessary to break the current in going from step to step.

The alternating-system throughout is figured on the basis of using a frequency of 2,000 alts. per minute (16 2-3 cycles). This frequency could be increased to, say, 3,000 alts. per minute (25 cycles) at the expense of, first, a considerably decreased power factor and consequently increased apparent kilowatts; second, increased generator and transformer capacity; third, increased line and rail loss, and, fourth, increased cost of motors. This difference might run the cost of the alternating-car equipment some 5 per cent higher than figured on. It will be noted that the great saving comes in changing from direct current to alternating current, and that a change in frequency within moderate limits affects a change by no means comparable with that which is affected by going to alternating current.

Operating Expenses.—In the labor item it will be noted that the main saving comes in that sub-station attendance is avoided by the use of the alternating system. In other respects the labor items will be the same. The fuel item for the alternating system is somewhat smaller than for the direct-current system, as the actual energy at the power house is less in the former case than in the latter.

Besides labor and power, the main operating expense for any interurban railway system comes in the items of repairs and maintenance. It will be noted that this item of repairs and maintenance has been included in the above comparison by assuming that it is a certain percentage of the first cost in each case. There may be some difference of opinion as to the percentage that should be assumed in the various cases of this item of repairs and maintenance, but I have endeavored to make the comparison between the two systems as fair as possible. It is not intended to include any item of depreciation in these repairs and maintenance figures. It will be noted that a marked difference is made between the maintenance of a third rail and trolley by allowing 1 per cent in the one case and 4 per cent in the other. The apparent discrepancy in allowing 5 per cent for the maintenance and repairs on the high-tension line and only 4 per cent for that of the trolley is explained by the fact that the 5 per cent on the high-tension line includes the repairs and maintenance and the supporting structure for the trolleys.

The matter of inspection of the alternating sub-stations is taken care of by allowing 6 per cent instead of 4 per cent, as in the direct-current sub-stations.

In the matter of repairs and maintenance of the car equipments, it will be noted that 12 per cent is allowed in the direct-current system and only 10 per cent in the alternating system. Even this difference in percentage allows $10,000 per year for the maintenance of the alternating equipments in the place of $7,500 for the direct current, or 25 per cent more for the former than for the latter. The alternating motors being lower in voltage and being protected from direct lightning discharges by the intervention of a transformer, ought to have at least a no higher maintenance bill than the direct-current motors. The number of motors in each case is the same. The alternating system, however, will require a certain amount of attention for the transformers and regulators. This item, though necessarily not based on experience, is estimated to represent the comparative conditions as closely as is possible at this time.

Grouping of Cells to Obtain Maximum Current.

BY DR. K. E. GUTHE.

IN two recent numbers of ELECTRICAL WORLD AND ENGINEER E. D. Pierce and W. J. Humphreys have given interesting proofs of the well-known condition for the arrangement of cells for maximum steady current.[1] It ought, however, to be pointed out that in the derivation of the formula the supposition is made that *the cells can be arranged in a simple parallel series, so that the internal and external resistances are equal.* This is frequently overlooked.

I believe the most practical equations for a given case are

$$p = \sqrt{N\frac{r}{R}} \quad \text{and} \quad E = e\sqrt{N\frac{R}{r}},$$

where N is the total number of cells, each of e.m.f. e and internal resistance r, R the external resistance, p the number of parallel sections and E the e.m.f. of the combination. The maximum steady current is then $i = \frac{e}{2r}\sqrt{N\frac{r}{R}} = \frac{ep}{2r}$, a formula which may sometimes be useful. Thus only if $N\frac{r}{R}$ equals 1, 4, 9, etc., will we be able to arrange the cells in a simple parallel series so as to make the internal equal to the external resistance.

Should the numerical values not allow such an arrangement, Mr. Pierce advises that the total internal resistance be made as nearly as possible equal to the resistance of the external circuit. This is not quite correct, as may be shown by a concrete example. Let $N = 14$, $e = 1$ volt, $r = 2$ ohms, $R = 16$ ohms. If all cells are connected in series, the internal resistance, r', equals 28 ohms, the difference $r' - R = 12$ ohms and $i = 0.318$ amp. If we arrange the cells in two parallel sections, $r' = 7$ ohms, $R - r' = 9$ ohms, and $i = 0.304$ amp.

In fact, *if we restrict ourselves to a simple parallel series* the cells

[1] E. D. Pierce, ELECTRICAL WORLD AND ENGINEER, Oct. 3; W. J. Humphreys, Oct. 24. Another simple proof may be found in Carhart's "Primary Batteries," p. 160.

should be arranged in such a way as to make the ratio between the two resistances as nearly as possible equal to unity. It can be shown that for a given ratio $a = \frac{R}{r'}$ we obtain the same current as if we make $a = \frac{r'}{R}$.

Call the internal resistance in the first case r_1', in the second r_2'

$$\text{Then } i_1 = \frac{s_1 e}{r_1' + R} = \frac{\frac{p_1}{r} e}{1 + a} \text{ and } i_2 = \frac{s_2 e}{r_2' + R} = \frac{\frac{s_2}{R} e}{1 + a},$$

$$r_1' r_2' = R^2 = \frac{s_1 s_2}{p_1 p_2} r^2,$$

$$\frac{N}{p_1 p_2} = \frac{R}{r} = \frac{s_2}{p_1},$$

$$\text{and } \frac{p_1}{r} = \frac{s_2}{R}, \qquad \therefore i_1 = i_2.$$

For maximum current a equals 1.

In case it is impossible to make $r' = R$, it is often better to abandon the simple parallel series. Since I have not seen a treatment of the general problem in any of our text-books on primary batteries, it seems to be of sufficient interest to outline the method briefly in the following: [2]

The problem may be divided into two parts: First, to arrange a given number of cells to a given e.m.f. so that the internal resistance of the battery is a minimum, and secondly, to find for a given number of cells and a given external resistance the e.m.f. which will give a maximum current.

We can in general arrange a number of cells in many different ways so as to give a definite e.m.f. The battery will consist of a series of sections each with a certain number of cells in parallel. Suppose that in one of these sections there are p cells and in another $p + 2$ cells. The sum of their resistances is $\frac{r}{p} + \frac{r}{p+2} = \frac{2p+2}{p(p+2)} r$ ohms. If we transfer one cell from the section with the larger number to that with the smaller number, the sum of the resistances becomes $\frac{2}{p+1} r$. But since $p \geq 1$, $\frac{p+1}{p(p+2)}$ is always larger than $\frac{1}{p+1}$ and the second arrangement gives the smaller internal resistance. Similarly $\frac{r}{p} + \frac{r}{p+3} > \frac{r}{p+1} + \frac{r}{p+2}$, etc. The smallest resistance for a number of cells to be arranged so as to give a definite e.m.f. $= a$ is, therefore, obtained by arranging them either in a simple parallel series or by grouping p in series with $p + 1$ parallel rows.

Such an arrangement is represented by the formula:

$$N = (a - \beta)\, p + \beta\, (p + 1) = a\, p + \beta.$$

After the value of a has been settled the arrangement we have to use is easily found. Let N be 9, $e = 1$ volt, $r = 2$ ohms. We desire to obtain minimum internal resistance with an e.m.f. $a = 4$ volts. N divided by a gives $p = 2$ and the remainder $\beta = 1$. We have, therefore, in this case two parallel series, each with 3 cells, and three parallel series, each with 1 cell, an arrangement which may be represented by $s\,p = 3 \times 2 + 1 \times 3$. The internal resistance is:

$$r' = \left(\frac{a - \beta}{p} + \frac{\beta}{p + 1} \right) r = 3\tfrac{2}{3} \text{ ohms.}$$

The second part of the problem consists in finding the best value of the e.m.f. $= a$ for a given external resistance.

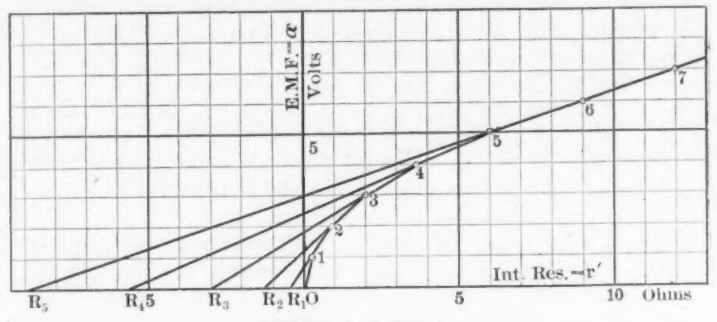
The method is most easily explained by a numerical example. Let, as before, $N = 9$, $e = 1$ volt, $r = 2$ ohms. For the different combinations we obtain the following table:

TABLE I.

a	1	2	3	4	5	6	7	8	9
P	9	4	3	2	1	1	1	1	1
β	0	1	0	1	4	3	2	1	0
r'	0.222	0.9	2.0	3.667	6	9	12	15	18
sxp	1x9	1x4+1x5	3x3	3x2+1x3	1x1+4x2	3x1+3x2	5x1+2x2	7x1+1x2	9x1

If we plot the a as ordinates and r' as abscissæ, we obtain a series of points 1, 2, . . . 9, as shown in the figure.

It is apparent that, if the external resistance, R, equals the length, $O R_n$ cut off on the negative X axis by the straight line through the points n and $n + 1$, the current is represented by the tangent of the angle, $O R_n n$ and this current will be the same for either $a = n$ or $a = n + 1$, while we obtain a larger current with $a = n$,



GROUPING OF CELLS.

or $a = n + 1$, according as R is smaller or larger than R_n. Thus for $0 < R < R_1$ the current is largest, if $a = 1$ volt; for $R_2 < R < R_4$, if $a = 4$ volts. We may, therefore, complete our table by adding the limiting values of R, which can easily be calculated from the equation,

$$R_n = n\,(r'_{n+1} - r'_n) - r'_n.$$

TABLE II.

$a =$	1	2	3	4	5	6	7	8	9
$R_n =$	0.456	1.3	3.0	5.667	9	9	9	9	∞

It can easily be shown that for $a > \frac{N}{2}$ all points lie on a straight line cutting the X axis at $R = \frac{Nr}{2}$, and that, therefore, for all values of $R > \frac{Nr}{2}$ the best arrangement of the cell is a single series, the e.m.f. being equal to Ne.

To find the maximum current if R is smaller than $\frac{Nr}{2}$, calculate $a = \sqrt{\frac{\overline{N R}}{r}}$ and determine p, β and R_n for this and the two neighboring points. The limiting values of R will immediately show which combination is to be used. Let, for our given case, R be 4 ohms; a will be $\sqrt{18}$, or about 4. The values of R_n for the points 3, 4 and 5 show that the combination 4 will give us the maximum current $i = 0.522$ amp.

The statement I made above, namely, that for maximum current the ratio of the external to the internal resistance should be as nearly as possible equal to unity, does not hold in the general case. For an external resistance of 2.8 ohms the best arrangement is with $a = 3$ volts, while the ratio of the two resistances is nearer unity if a equals 4 volts. The above rule, therefore, applies only if we restrict ourselves to grouping the cells in a simple parallel series.

[2] This problem was first solved by Wassmuth in Carl's "Repertorium der Physik," 1878, p. 536. I shall follow him to a certain extent in my derivation of the formulae.

Montreal, the Greatest Centre of Transmitted Power.—II.

By Alton D. Adams.

SUB-STATION WORK.

At the McCord Street sub-station the 4,000-volt, three-phase, 63-cycle current from the plant at Lachine Rapids is transformed for distribution to 2,400 volts. This transformation is effected by means of twelve transformers of 250 kw each, and four transformers rated at 1,000 kw each. The combined capacity of these transformers is thus 7,000 kw. The four transformers of 1,000 kw each are connected so as to change the current from three-phase on the primary coils to two-phase on the secondary coils.

At the Shawinigan sub-station in Maisonneuve, a suberb of Montreal, but not within the city limits, the three-phase circuit of three aluminum conductors delivers current at about 44,000 volts and 30 cycles. The generating plant at Shawinigan Falls, on the St. Maurice River, already described in these pages, delivers current to the transmission line at approximately 50,000 volts, but the loss in conductors reduces the terminal pressure to about that just stated for the sub-station. Each of the three conductors of the transmission line, after entering the sub-station, is connected to a series of 44 lightning arresters with six air-gaps each, giving 264 air-gaps between each line and the ground. Between the connection to lightning arresters and the connection to transformers two static interrupters are connected to each of the three high-tension wires. Each of these interrupters is single-pole, and rated at 50,000 volts, 26 amp., and 2,600 alternations per minute. From the interrupters the 44,000-volt circuit

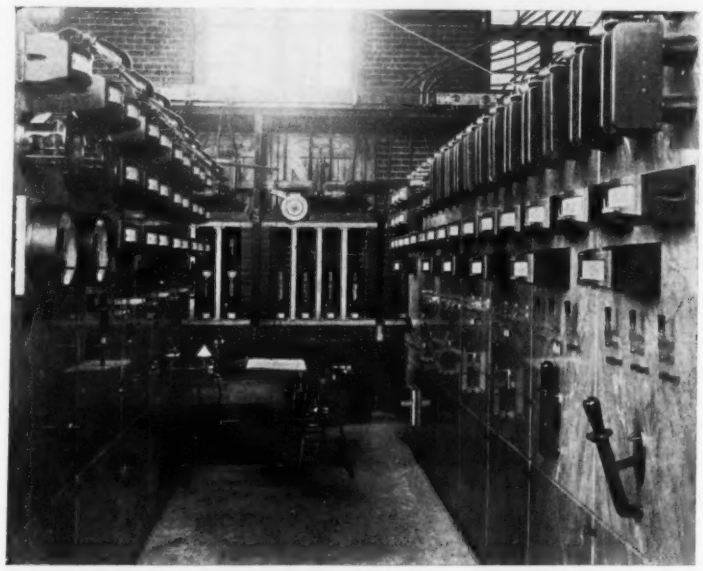


FIG. 9.—DISTRIBUTION BOARD AT SHAWINIGAN SUB-STATION.

passes to five oil-cooled transformers, which are rated individually at 1,000 kw, with current at 30 cycles, and at 2,000 kw with current at 60 cycles per second. By these transformers the three-phase current is reduced from 44,000 to 2,400 volts, and then passes to five motor-generators that change the frequency from 30 to 63 cycles per second. As at first installed, two of these motor-generators delivered three-phase current at 63 cycles and 2,400 volts, and three of the motor-generators delivered two-phase current of the same frequency and voltage. It is the intention, however, to change two of the motor-generators so that the entire five will generate two-phase current. From these motor-generators the 2,400-volt, 63-cycle current passes to a switchboard in another part of the sub-station, and is thence distributed in part directly to customers of the Montreal Light, Heat & Power Company, and in part by passing through the central sub-station of that company. Under a 50-year contract between the Shawinigan Water & Power Company and the Montreal Light, Heat & Power Company all of the energy delivered by the former is received by the Montreal electrical supply system save that a short local railway has the right to use a maximum of 250 hp. The switchboard installed by the Montreal Light, Heat & Power Company is provided with motor-driven and manual oil switches that connect the 2,400-volt, 63-cycle bus-bars with the various service feeders. This switchboard is also provided with indicating volt and amperemeters and recording wattmeters. The five 1,000-kw, 30-cycle, oil-cooled transformers, already mentioned, that reduce the transmitted energy from 44,000 to 2,400 volts pressure are worthy of note for their large dimensions. The tank of boiler iron, filled with oil, that contains each of these transformers, is cylindrical in form, 15 ft. high, 7½ ft. in diameter, and contains 750 gallons of petroleum. Each of the five motor-generators that receive the current from these transformers is made up of three complete machines, a 2,400-volt, 30-cycle, three-phase, synchronous motor, a 2,400-volt, 63-cycle, two or three-phase alternator, and a 125-volt, direct-current exciter of 583-amp. capacity. These three machines are direct-connected and operate at the common speed of 450 r.p.m. The motor and alternator are both of the type with internal revolving magnets, and stationary armature coils. A solid coupling unites the shafts of the motor and alternator and the extended shaft of the latter carries the armature of the exciter. The exciter magnet frame is mounted on a solid extension of the alternator base. To secure alignment of the motor and alternator in each unit their bases are bolted to four 15-in. I-beams that are embedded in the concrete foundation. Each I-beam is 25 ft. long. The extreme width of each motor and alternator base is 11 ft. 2 in. From the bottom of the I-beams to the top of the motor frame the distance is 9 ft. 5¼ in. Over the three machines that make up each motor-generator unit the extreme length parallel to the shaft is 29 ft. 5 5/16 in. Each direct-current exciter furnishes current to the magnet coils of both the motor and alternator to which it is mechanically connected. In the sub-station with the five motor-generators just considered there is a smaller motor-generator made up of a 100-hp, 30-cycle, three-phase, 2,300-volt motor, direct-connected to an 85-kw, 125-volt generator. Current for this 100-hp motor is taken directly from the secondary side of the static transformers. When one of the large motor-generators is to be started, each of which is rated at 800 kw, the 85-kw generator is driven by the 100-hp motor, taking current from the secondaries of the static transformers, and the 125-volt direct current thus obtained is used to operate the exciter of the large motor-generator as a motor. As soon as the large motor-generator reaches its synchronous speed its motor is connected to the transformers that deliver energy from Shawinigan Falls, and the 85-kw dynamo is disconnected.

The building for the Shawinigan sub-station is of brick, one story high, with a roof supported on steel trusses, and a concrete floor. Internally the main building is divided into two parts by a brick wall parallel to its longer sides. In one of the two rooms thus formed the five 1,000-kw transformers are located, and in the other room are the motor-generators. On the ground the main building measures approximately 95 by 115 ft. A one-story brick wing at one side of the main Shawinigan sub-station contains the switchboard equipments through which energy is delivered to the lines of the electrical supply system.

THE CENTRAL SUB-STATION.

The central sub-station located in the block bounded by Ottawa, Wellington, Prince and Queen Streets is the largest and most important connected with the Montreal system of electrical distribution. To this sub-station come the high-tension transmission lines from the water power plants at Lachine Rapids, Chambly, while the Shawinigan system is also connected through the 2,300-volt feeders that come from the Shawinigan sub-station. Energy at 2,000 volts, 63 cycles two-phase from the McCord Street Station, and at 22,000 volts, 63 cycles, three-phase from Chambly, is transformed at the central sub-station to current at 2,300 volts, 63 cycles, two-phase, for general distribution. Ultimately, the equipment of main transformers at the central sub-station will comprise sixteen units of 2,750 kw each, and of these units ten are already installed, giving a present capacity of 27,500 kw. These transformers are of the air blast type, and were made by the Westinghouse Electric Manufacturing Company. Besides these main transformers receiving energy direct from the transmission lines, the central sub-station contains thirty transformers of 60 kw capacity each, for the operation of enclosed, alternating arc lamps in series for street lighting. Each of these transformers with its regulator delivers a constant, alternating current of 7.5 amp. and a maximum pressure of 4,000 volts. These constant-current transformers, which take energy from the main transformers at 2,400 volts and deliver it at any desired voltage up to 4,000, were made by the Western Electric Company.

Current for the 250 and 500-volt, three-wire system, which operates direct-current motors, is supplied by two motor generators at the central sub-station. Each of these motor generators is made up of a 300 kw, 2,400-volt, two-phase synchronous motor, and a 250 kw, 250-

volt, direct-current generator. These two synchronous motors draw their energy from the main transformers. To maintain the pressure in the air chamber beneath the air-blast transformers, space has been provided on the main floor of the sub-station for four blower units, and three of these units are in position. Each blower unit is made up of one 40 hp, 550-volt, two-phase induction motor, of Westinghouse make, with a centrifugal blower with a 32-inch circular opening on each end of its shaft. These blowers were made by the Sturtevant Company, and are intended to maintain a pressure of 1.8 inches of water per square inch.

Provision is also made on the main floor for two motor-driven exciters to furnish direct-current to the magnets of the large machines, and also for an emergency set consisting of a 300 kw, 2,400-volt, two-phase synchronous motor direct-connected to an alternator of equal capacity. All of the transforming and converting apparatus just named occupies a central position on the main floor of the sub-station, save the constant-current transformers. Ranged about three sides of the sub-station in galleries and on one side at the main floor level are the high and low-tension switchboards that receive, control and distribute the energy from the water power plants. In the gallery on one of these three sides are the marble and soapstone compartments that contain the knife switches for the high-tension lines from the water power plants. From these switches the 22,000-volt, three-phase circuits pass to the primary coils of the main transformers. The secondary, 2,400-volt circuits from these same transformers go to the transformer panels and distributing board in the gallery on another side of the sub-station, by the way of manually operated oil switches located in the same gallery. The gallery on a third side contains another portion of the distributing switchboard. Beneath the gallery on one side of the sub-station are the thirty constant-current transformers already mentioned, on the main floor. An arc lamp switchboard, connecting these transformers with the series circuits for street lighting, separates the space beneath the gallery last

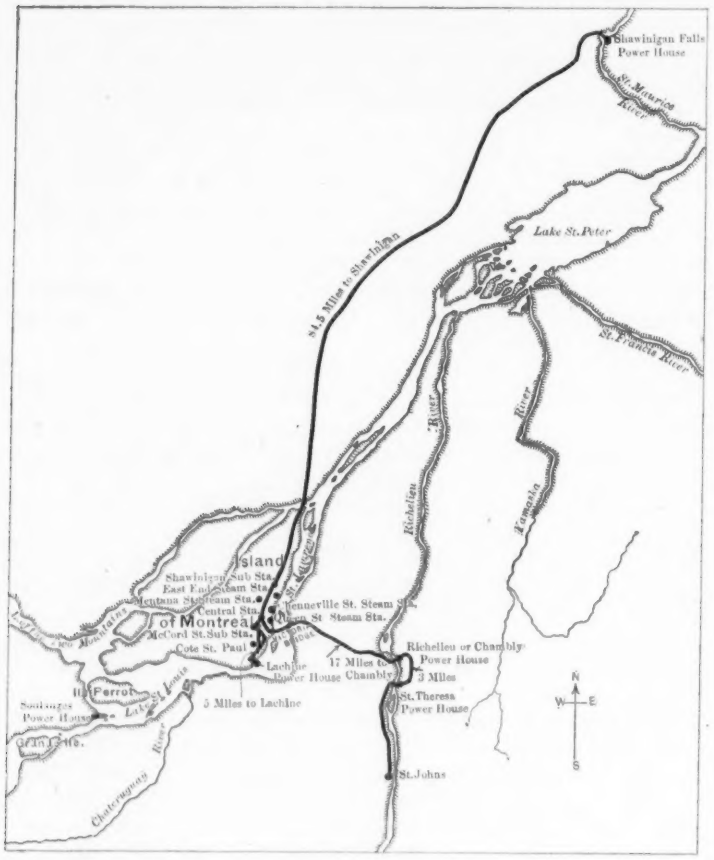


FIG. 10.—MAP SHOWING LOCATION OF WATER POWER PLANTS AND DISTRIBUTING STATIONS.

named from the central portion of the main floor, where the large transformers, motors and motor-generators are located. This arc switchboard is the only one on the main floor level. The fourth side or front of the sub-station, where the large, main entrance is located, is free from electrical apparatus, and starting from this side a traveling crane sweeps the entire central space of the main floor. This crane is driven by electric motors, and has a capacity of 30,000 pounds. It was built by the Niles Company.

The building of the central sub-station is one of the largest and best to be found anywhere for this purpose. Because of the high voltage and great amount of energy entering this sub-station, and its importance in the Montreal electrical supply system, it was located in about the center of a city block, so that a large, clear space was left between each of its outside walls and the public street. The block of land in which the sub-station is located measures 195 ft. 4 inches wide on Ottawa Street, 238 ft. along Queen Street, at right angles to Ottawa

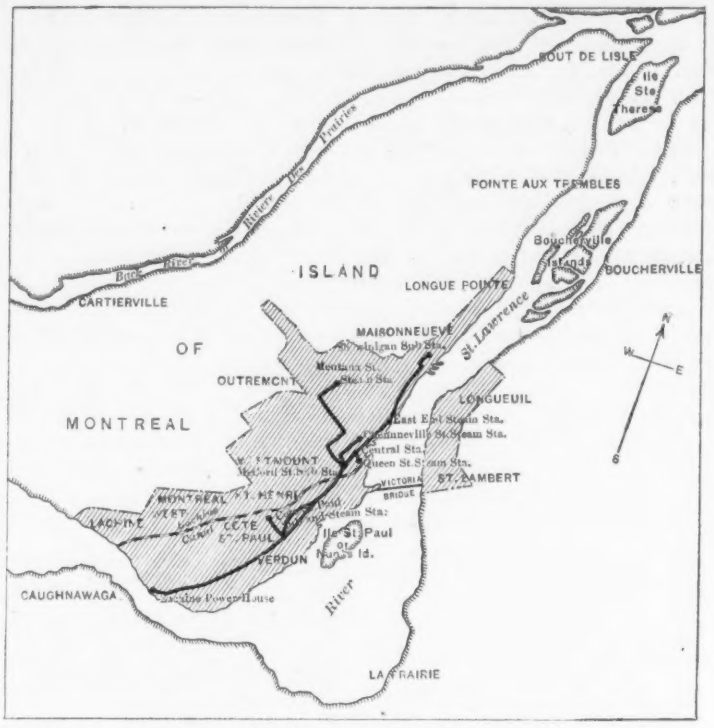


FIG. 11.—MAP SHOWING LOCATION OF SUB-STATIONS AND THE DISTRICT COVERED BY THE SERVICE.

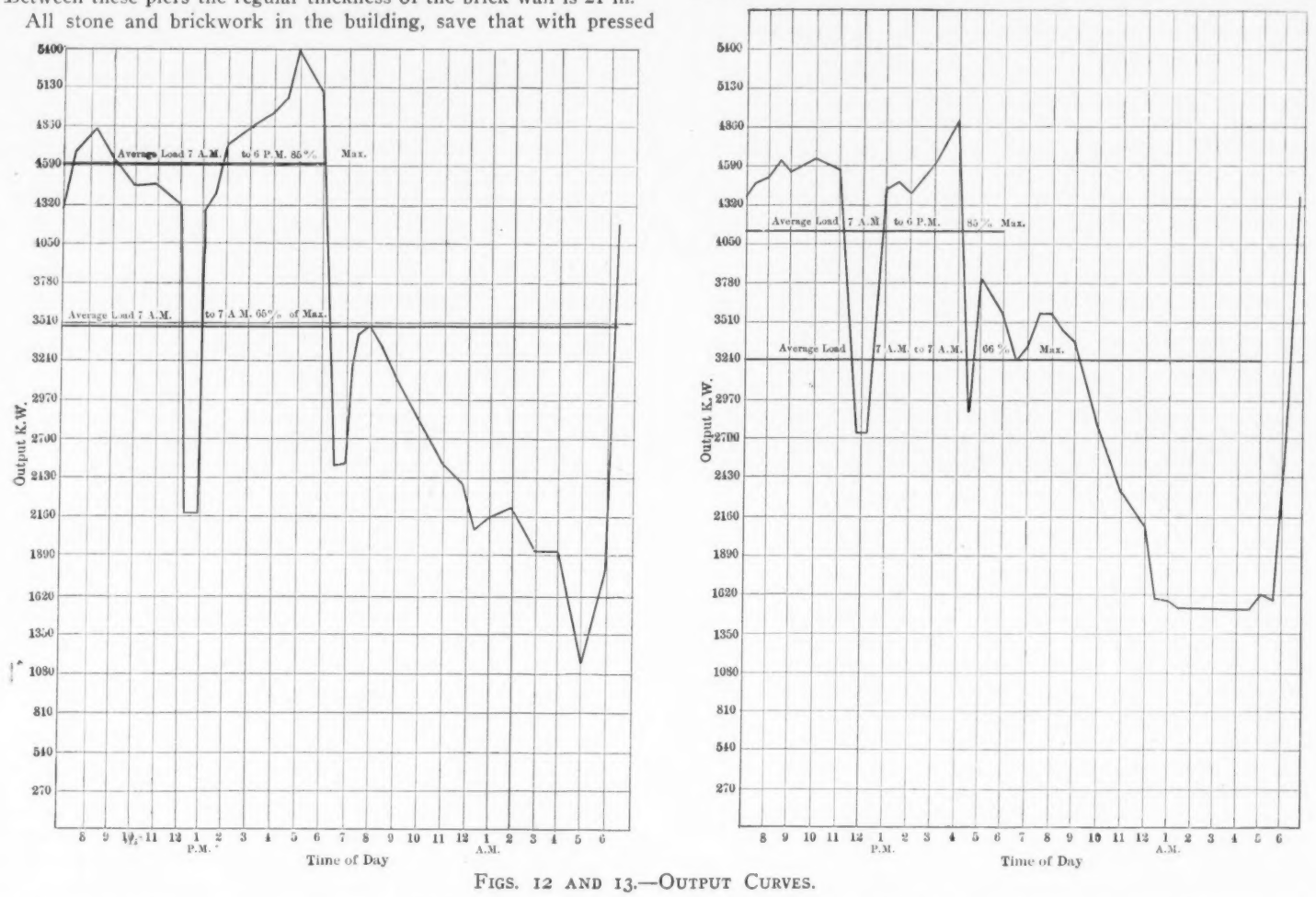
Street, to Wellington Street, and 310 ft. 8 inches along Prince Street, parallel with Queen Street, to Wellington Street. In front the sub-station sets back 94 ft. from Ottawa Street; one side is 35 ft. 8 in. from Queen Street, another side is 56 ft. 8 in. from Prince Street, and the rear corner nearest to Wellington Street is 27.5 ft. therefrom. From the wall of the sub-station to the buildings on the opposite side of Queen Street is 73 ft. 10 in.; from the sub-station to the buildings on the opposite side of Prince Street is also 73 ft. 10 in., and the buildings nearest the rear corner on Wellington Street are 74 ft. distant. The vital importance of these figures may be appreciated from the fact that the central sub-stations is located in a solidily built business portion of the city. The sub-station building is one story high above the basement, nearly square in outline, of pleasing architecture, and as nearly fire-proof from foundation to roof as steel and masonry can make it.

Inside the central sub-station at the main floor level the dimensions are 118 ft. by 122.5 ft., and from main floor to the lower cord of the steel roof trusses is 34.5 ft. The lowest part of the roof outside is 41 ft. above the main floor. At an elevation of 10 ft. above the main floor is the switchboard gallery that has been previously mentioned, which extends around three sides of the building. Another gallery 14.5 ft. above that just named, and located on parts of two sides of the sub-station, gives access to lightning arresters and knife switches on the distribution circuits. Beneath the entire main floor there is a basement paved with concrete 1 ft. thick. The surface of this concrete is 7 ft. 10½ in. below the main floor around the outer portion and 11 ft. below in the central portion of the building. In this central portion of the basement a space 37 ft. 8 in. by 65 ft. 2 in. is enclosed for an air pressure chamber by masonry walls each 2 ft. thick. On the main floor over this air chamber are set the sixteen 2,750-kw transformers and the four blower units. The floor space actually occupied by the group of transformers with an aggregate capacity of 44,000 kw is within 38 by 40 ft., and it may be doubted whether an equal capacity of transformers can be found within so small a space elsewhere. Beneath each transformer and each blower an opening in the main floor permits the movement of air out of or into the chamber. The air forced into the chamber by the blowers rises through the transformers and may escape through the windows in the side walls, or the skylight.

The sub-station receives daylight through high windows in each of its four sides, and through windows in the sides of the skylight which extends along the center of the roof between two opposite sides of the building. Light and ventilation for that part of the basement next to the outside walls is secured by small windows along the foundation wall and a little above the ground level. All windows about the sub-station are framed in channel, T or angle iron, and fitted with ⅜-in. wired plate glass. In its central portion the main floor of the sub-station was designed to support a superimposed load of 400 pounds per square foot, and along the sides beneath the galleries the design was for 70 pounds per square foot. Seventy pounds per square foot was the specification for the strength of all gallery floors. For the roof a safe capacity of 125 pounds per square foot was required. Structurally the sub-station is composed almost entirely of brick, tile, steel and stone. The stone foundation extends from 9 ft. 8 in. below to 5 ft. 3 in. above the ground line, and its footing 7.5 ft. wide rests on natural soil. Above this stone foundation the walls are of brick with heavy stone belt courses, plinth course, pier blocks, lintel, moulded course, pilasters and coping. At intervals along their outsides, and at the corners the brick walls are reinforced by heavy piers. Between these piers the regular thickness of the brick wall is 21 in.

All stone and brickwork in the building, save that with pressed brick, was laid with a mortar composed of one part Portland cement and two parts sharp sand. Spaced along the brick walls of the sub-station with their footings in the stone foundation, and also along two sides of its central floor space, are a number of steel columns that support the I-beams for the main floor and the gallery floors, the traveling crane and also the steel roof trusses. The brick walls thus carry only their own weight. Under the central part of the main floor there are independent foundations that carry the heavy machinery there located. As a part of the steel columns is built into the brick walls, the stability of the latter as to any side strains is thereby greatly increased, the steel work being tied together from one side of the station to the other. Steel I-beams carried by the vertical columns and the central foundation walls and piers support the main floor of the sub-station. The first or lower gallery floors are also laid on I-beams secured to the vertical columns. In the second or upper gallery the floor is laid on heavy angle steel shapes that are carried with their supports by the columns in the brick walls. The framework of stairways leading from the basement to main floor, from the main floor to the first gallery, and so on up to the second gallery, and the roof is of iron and steel, and the treads are of slate. A framework for the sides and roof of the skylight is built up of angle steel and I-beams resting on the steel trusses carry the main roof.

The main floor, that of the first gallery and the roof, are all built up of terracotta arches. On the second gallery the floor is laid with slate slabs. On the main and first gallery floors the tile arches are covered with a granolithic mixture of cement, sand and crushed granite 2½ in. thick. Over the terracotta blocks and I-beams of the roof a coating of cement mortar at least ½ in. thick was laid to an even surface. On this surface there was placed a layer of boiling pitch, and then tarred felt roofing with another outside coating of the pitch. After this last was dry, boiling asphalt was spread over the roof to a depth of ¾ in., and in this hot asphalt book tiles 1 in. were laid with ¼-in. joints. The ceiling of the roof was plastered with a mortar composed of one part cement and two of sand, and then with cement and plaster of paris.



FIGS. 12 AND 13.—OUTPUT CURVES.

ECONOMIC ASPECTS.

The showing of 46 per cent. of the gross earnings as net income in the Montreal system, as above noted, has been made through good engineering. This will be appreciated from the fact that the regular rate for electric lighting in Montreal is 15 cents per kw-hour, while the rates to very large consumers like the cotton mills and the street railway compare favorably with the cost of steam power. Without neglecting the various other elements that affect the operative efficiency of a great system like that at Montreal, a special effort has there been made to reduce losses in distribution and build up a relatively large day load of motors. As has already been pointed out, the Royal Electric Company was the largest distributor of electrical energy in Montreal prior to the formation of the Montreal Light, Heat & Power Company, of which the former company is now one of the constituent units. In 1896 Mr. P. G. Gossler, at present general superintendent and engineer of the Montreal Company, occupied a like position with the Royal Company, and a paper presented by him at the annual convention of the Canadian Electrical Association, in that year, gives some interesting facts as to the methods followed to reduce distribution losses in the system of this latter company.

Among these facts the results of changes in the number and type of service transformers may be noted. The object in these changes was to displace smaller transformers by a less number of larger ones,

and to supply consumers as far as practicable from secondary mains having approximately the lamp voltage. Following out this idea, reconstruction was begun on the alternating lighting service of the Royal Company, which included 1,160 transformers wired up to about 53,000 incandescent lamps. In the course of this reconstruction 473 of the old transformers were removed, 345 being replaced by new transformers, 18 taken down because the service was discontinued, and 110 disconnected because the customers served by them were connected to other old transformers nearby. Meantime 229 new transformers were connected to the lines, and of these 187 replaced old transformers, and 42 were used for new customers. These changes left 916 transformers wired up to 60,000 lamps. With the 1,160 transformers and 53,000 lamps on the lines during the year preceding this reconstruction the smallest load at the station was 380 amp. During ten months after the reconstruction the minimum load on the station with 916 transformers and 60,000 lamps connected to the lines was 245 amp., or 135 amp. less than that with the previous smaller number of lamps and larger number of transformers. This saving of 135 amp. in the minimum load was obviously due to less leakage of current through the new transformers than through the smaller ones that were removed. For the 229 new transformers the leakage current was 19 amp., from which it follows that the leakage of the 473 old transformers that were removed amounted to $135 + 19 = 154$ amp. Of the total saving of 135 amp. in leakage current, 36 amp. was due to the removal of the 110 transformers whose lamps were connected to other old transformers through secondary distribution mains. From this it appears that by replacing 345 of the old by 187 new transformers a saving of 99 amp. in leakage current was effected. The entire cost of making the changes in the 187 transformers and the distribution lines, including the cost of the new transformers, amounted to $65 per transformer on an average after the value of the old transformers, as scrap, was deducted. It was computed that the saving in the cost of coal at $2.75 per ton amounted to $25.58 annually for each of the 187 transformers on an average, so that the reduction in the outlay for fuel alone would pay for the change in about 2½ years. It was also computed that when the 1,160 old transformers have all been replaced by 636 new transformers the leakage current would be reduced to less than 75 amp. As the Montreal plant was operated 24 hours per day it was further estimated that the reduction of 135 amp. in the leakage current resulted in a yearly saving of $7,348 for coal at $2.75 per ton. Looking at the 135 amp. as capacity for an increase of load, it was said to correspond with 2,700 lamps of 16 cp in operation, or about 9,000 such lamps connected to the system.

Perhaps the most notable result in the operation of the distribution system at Montreal, as it stands to-day, is the great increase in the connected load of stationary motors, and the relation of this motor load to the maximum load at the station. These results are brought out clearly by the records of kilowatt outputs during a December day of 1900, and an April day of 1901, at the station of the Royal Electric Company. During the 24 hours of the December day the average load at this station was 66 per cent. of the maximum load, and during the 24 hours of the April day the average load was 65 per cent. of the maximum there. These exceptionally high average loads show at once the influence of the relatively great capacity of connected motors, but the mystery is how a day load of motors, however great, can bring the average so far up toward the maximum load. As is well known, a day load of motors operating from 7 A. M. to 6 P. M. laps well over onto the heavy lighting load during the late hours of each afternoon during the winter months, and thus presents a direct addition to the maximum station load. With the great motor load at Montreal it has been necessary to avoid the conjunction of the normal motor and the maximum lighting demands. That this result has been reached at Montreal may be gathered from the fact that the average load at the station of the Royal Electric Company from 7 A.M. to 6 P.M. was not only 85 per cent. of the maximum load during the April day, but was also 85 per cent. of the maximum on the December day, when the annual maximum of the lighting load would naturally be reached. The fact that the regular motor and the maximum lighting loads do not coincide on the Montreal system is made still more evident by the location of the maximum station loads as to time of day in winter and spring. On the April day above mentioned the maximum station load occurred at 5 P.M., and on the December day this maximum came just prior to 4 P.M. Light must be had when wanted in Montreal, as elsewhere, and the maximum station load in December was kept down by cutting off a large part of the motor capacity before the great bulk of the lamps were turned on.

This disconnection of a large part of the motor load at 4 P.M. during the winter months is provided for in the contracts with some of the heaviest power users at Montreal, and the merit of the plan is shown by its success. If large consumers of power are able to purchase it at a very attractive figure prior to 4 P.M. on each day, there seems to be no good reason why they should not do so even though the supply is not available after that hour. The success of power sales on this basis seems to be in the nature of a personal triumph for Mr. P. G. Gossler, who has advocated it for several years.

Electric Traffic in Greater New York.

The Interborough Railway Company has decided in conference with the State Railroad Commission to put on more trains at once, travel having increased rapidly again under the electric régime on the Manhattan Elevated. The company prepared a statement for the Commission showing the number of cars available and the number that can be made ready for use at short notice. According to this the company is embarrassed by the fact that of the 500 subway cars that were to have been available for use on the elevated road by this time less than 200 are ready for use. The statement in part is as follows: "In addition to the delay in getting the cars as anticipated, we have been delayed in receiving the electrical equipment of these cars. Every effort has been made and every argument used that contractors connected with any part of this service should not only push their contracts to completion on time, but anticipate them if possible. A cable or tie has been laid between the Fifty-ninth Street power house and the Manhattan power house, at Seventy-fourth Street, at a cost of $125,000, in order to be ready to make use of any power which may be generated in the Fifty-ninth Street power house on the Manhattan division. The increase in passengers carried in the month of October was 3,000,000 over October, 1902, and the car mileage increase was 1,146,716. For November the increase in passengers was 2,972,000, and the increase in car mileage was 1,052,470."

It was further stated that the company had ample power for present needs, and that the deficiency in cars was being decreased at the rate of three per day.

Over in Brooklyn the Commission has also found problems for consideration and has ordered the Brooklyn Heights Railway Company to secure and operate at once 50 more cars. It is also evident from the report of the Commissioners that the system remains sorely in need of more generator capacity. The maximum number of cars which will be operated during the rush hours the coming winter on the surface lines, including service cars, will be about 1,200. The average number of cars operated during the non-rush hours will be about 545. The report remarks:

"The natural query is if the company can operate 1,200 cars during the rush hours, why can it not operate more than an average of 545 during the non-rush hours?" the report says. Then it answers: "The reason for this large difference in the number of cars operated during different portions of the day is that in order to as nearly as possible accommodate the traffic during the rush hours, the power apparatus is worked to a point far beyond its normal capacity. In the case of electric generating apparatus, this can be done for short consecutive intervals, but during this time of overload the apparatus becomes so warm that if the overload is continued permanent injury will be caused to the machines, and, with the limited amount of generating apparatus which the company has, all the different units must be employed during these hours to furnish even the inadequate facilities which are given at present. After the rush hours the load must be reduced and the machines allowed to regain their normal temperature, and during the non-rush hours some of the units must be shut down each day for repairs, hence the necessity for reducing the number of cars operated during these hours."

A large number of extra cars has already been put into service in New York City, as above stated, and the service is also under increase in Brooklyn. The Sixth Avenue cars on the New York Elevated to relieve pressure are switched back at the Franklin street loop. It is a matter of general comment that electric traction has induced a large amount of new patronage from business men below that point during all hours of the day, on account of the economy of time.

Calculation of the Apparent Inductance in Armature Coils.—V. (*Concluded.*)

BY C. C. HAWKINS.

II. CALCULATION OF L_s.

10. *Calculation of Ls.*

The apparent inductance of a single section, L_s, at the last moment of short-circuit when the current within it diverges from the straight-line condition must, as Prof. Arnold has pointed out, further take into account the damping action from the adjacent sections which are still undergoing short-circuit at the same moment. And in the due allowance for this lies the difficulty of the required calculation, so that it is hardly possible to do more than lay down the maximum value that L_s is likely to attain. To be on the safe side, therefore, the coil must always be considered in that position relatively to the slots which gives the minimum damping, since when the circuit is opened in this position sparking is most likely to occur. Experiment, indeed, even with closely adjacent coils, hardly shows the amount of damping to be as much as might be expected.

Taking the different classes of winding in the same order as before,

(I) with $\frac{N_2}{2p}$ a whole number, two spool sides simultaneously pass out of short-circuit in each interpolar zone, and the mutual inductance from the spool sides, B, B_x, assists the self-inductance of coil AA' (Figs. 2 — 6), since they are all at the same epoch of commutation. Hence,

$$L_s = (L + M) - \Sigma.\left(\frac{M^2}{L}\right) = kd\,(L + M),$$

where $-\Sigma\left(\frac{M^2}{L}\right)$ represents the damping effect of all the other different sections which are simultaneously short-circuited in the same pair of zones, or this may be taken into account by a certain damping factor, kd less than unity.

In subdivision (IA) when the slots are also divisible by $2p$,

(1) With *diametric* winding the two spool sides which simultaneously pass out of short-circuit in each zone are then in one and the same slot and one above the other, so that

$$L + M = \left(\frac{\tau}{N^2}\right)^2 \left[l\left(4.19\,\frac{t}{w_s} + 12.57\,\frac{t_3}{w_3} + 9.2\,log\,\frac{\pi\left(r_2 - \frac{w_s}{2}\right) + w_s}{w_s}\right) + l'\left(2.3\,log\,\frac{l'}{d_s} - 0.45\right)\right] \times 10^{-9}\ \text{henrys.}$$

where d_s is the diameter of a circle whose periphery is equal to that of the end connection of the entire spool. With a single solid bar per spool side, some allowance must be made by reducing the constant 4.19 for screening within its mass, since all the flux within the slot is not linked with the whole of the bar. The values of

$$9.2\,log\,\frac{\pi\left(r_2 - \frac{w_s}{2}\right) + w_s}{w_s}$$

for the surface of the core per cm. length are plotted in the upper curve of Fig. 34.

Whatever the number of spool sides per slot, the spool sides nearest to the trailing edge of the slot must finally come out of short-circuit without any dampers within their own slot, so that for assistance in the suppression of sparking reliance can only be placed on the damping from the simultaneously short-circuited coils in the adjacent slots, so far as they have mutual inductance with the considered section. In other words, though other sections may be more favorably situated, there is in the case of the last section in each slot no damping within the slot itself; kd is thus not far removed from unity, since damping only arises so far as the surface-of-the-core flux is linked with other sections and in a less degree from the influence of the end connections. To this is partly to be attributed the fact that when there are several sections per slot it is usually the trailing section which first shows traces of sparking. The larger the armature, the greater is the proportion of the flux corresponding to L which is linked with other simultaneously short-circuited spool sides; the damping is also greater with an increase in the number of spool sides per slot, since a large number of spool sides per slot is usually accompanied by an increase in the value of s; hence the value of kd may be given some such decreasing values as:

0.95	with	2	spool	sides	per	slot.
0.9	"	4	"	"	"	"
0.85	"	6	"	"	"	"
0.8	"	8	"	"	"	"

(2) *Very long chord winding.*—The expression for $L + M$ is the same as above, but the damping factor is slightly increased, since now there is always at least one and there may be more (up to $\frac{kn}{2} - 1$) dampers within the same slot as the trailing sector when just going out of short-circuit. With four spool sides per slot, and $s = 2$, there is always one damper within each of the two slots; with six spool sides per slot, and $s = 2$, there is one damper in each slot; but when $s > 2$, there are either one or two dampers per slot,

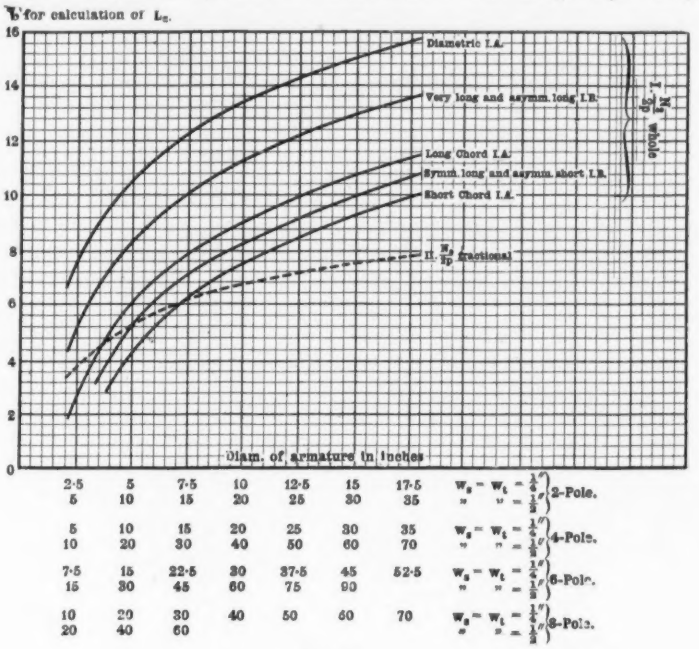


FIG. 34.

according to the degree of the chord winding. Similarly with eight spool sides per slot, and $s > 4$, there are one, two or three dampers according to the degree of the chord winding, and with ten spool sides per slot and $s = 5$ there are one, two, three or four dampers per slot.

(3) *Long chord winding.*—The spool sides, A', B and A, Bx are now no longer within the same slot respectively, but are divided by one tooth, so that the self and mutual inductance is reduced to

$$L + M = \left(\frac{\tau}{N_2}\right)^2 \left[l\left(2.61\,\frac{t}{w_s} + 6.28\,\frac{t_3}{w_3} + 4.6\,\log\,\frac{\pi\,\frac{w_t}{2} + w_s}{w_s} + 9.2\,\log\,\frac{\pi\left\{r_2 - \left(\frac{w_t}{2} + w_s\right)\right\} + w_t + 2\,w_s}{\pi\,\frac{w_t}{2} + w_t + 2\,w_s}\right) + l'\left(2.3\,\log\,\frac{l'}{d_s} - 0.45\right)\right] \times 10^{-9}\ \text{henrys}$$

At the same time the damping is reduced, since in one slot there is no damper present; in the other slot, so long as $s < \frac{kn}{2}$, there are

$s - 1$ damper wires, which reach a constant value of $\frac{kn}{2}$ so soon as $s > \frac{kn}{2}$.

(4) *Short chord winding.*—The two analogous spool sides being separated by two teeth and one slot, there is a still further reduction, and

$$L + M = \left(\frac{\tau}{N_2}\right)^2 \left[l \left(2.61 \frac{t}{w_s} + 6.28 \frac{t_3}{w_3} + 4.6 \log \frac{\pi\, wt + w_s}{w_s} + 9.2 \log \frac{\pi \{ r_2 \quad (wt + 1.5\, w_s) \} + 2\, wt + 3\, w_s}{\pi\, wt + 2\, wt + 3\, w_s} \right) + l' \left(2.3 \log \frac{l'}{d_s} - 0.45 \right) \right] \times 10^{-9} \text{ henrys}$$

Again, in one slot there is no damper, and in the other so soon as $s > \frac{kn}{2} + 1$, there are one, two, three or more dampers up to a maximum of $\frac{kn}{2}$ when $s > kn$.

In subdivision (*IB*) with number of slots not divisible by $2p$. (1) *very long chord* and (2) *asymmetrical long* yield two spool sides coming out of short-circuit simultaneously in one slot, and two spool sides in the adjacent zone divided by one tooth. Hence, $L + M$ is intermediate between (1) and (3) of subdivision (*IA*); or

$$L + M = \left(\frac{\tau}{N_2}\right)^2 \left[l \left(3.4 \frac{t}{w_s} + 9.4 \frac{t_3}{w_3} + 4.6 \log \frac{\pi \left(r_2 - \frac{w_s}{2} \right) + w_s}{w_s} + 2.3 \log \frac{\pi \frac{wt}{2} + w_s}{w_s} + 4.6 \log \frac{\pi \left\{ r_2 - \left(\frac{wt}{2} + w_s \right) \right\} + wt + 2\, w_s}{\pi \frac{wt}{2} + wt + 2\, w_s} \right) + l' \left(2.3 \log \frac{l'}{d_s} - 0.45 \right) \right] \times 10^{-9} \text{ henrys.}$$

In one zone there is no damper within the slot, and in the other there are one or more increasing with the value of the remainder from slots $\div 2p$.

(3) *Symmetrical long* and (4) *asymmetrical short* yield two spool sides divided by one tooth and two spool sides divided by two teeth and one slot, so that their $L + M$ falls between (3) and (4) of subdivision (*IA*); or

$$L + M = \left(\frac{\tau}{N_2}\right)^2 \left[l \left(2.61 \frac{t}{w_s} + 6.28 \frac{t_3}{w_3} + 2.3 \log \frac{\pi \frac{wt}{2} + w_s}{w_s} + 2.3 \log \frac{\pi\, wt + w_s}{w_s} + 4.6 \log \frac{\pi \left\{ r_2 - \left(\frac{wt}{2} + w_s \right) \right\} + wt + 2 w_s}{\pi \frac{wt}{2} + wt + 2\, w_s} + 4.6 \log \frac{\pi \{ r_2 - (wt + 1.5\, w_s) \} + 2\, wt + 3\, w_s}{\pi\, wt + 2\, wt + 3\, w_s} \right) + l' \left(2.3 \log \frac{l'}{d_s} - 0.45 \right) \right] \times 10^{-9} \text{ henrys.}$$

The damping effect from the slots is also further reduced.

(*II*) With $\frac{N_2}{2p}$ fractional.

In this class only one spool side passes out short-circuit at any one moment in each interpolar zone, so that there is no mutual inductance and a single expression suits all cases, viz.:

$$L_s = L - \Sigma \left(\frac{M^2}{L} \right) = kd\, L,$$

where $L = \left(\frac{\tau}{N_2}\right)^2 \left[l \left(2.09 \frac{t}{w_s} + 6.28 \frac{t_3}{w_3} + 4.6 \log \frac{\pi \left(r_2 - \frac{w_s}{2} \right) + w_s}{w_s} \right) + l' \left(2.3 \log \frac{l'}{d_s} - 0.45 \right) \right] \times 10^{-9}$ henrys,

when there are as many sets of brushes as poles; in the series-connected multipolar armature with only two sets of brushes, the above expression must be multiplied by p.

The calculation of the terms which deal with the surface of the core is much abbreviated by the use of the curves of Fig. 34, which give the total value of $b + b' +$, etc., per cm. length of core. Obviously the coefficient for fractional windings is exactly half of that for diametric, and this is true not only for the surface of the core, but also for the slot inductance. There is, however, such an appreciable reduction with short or even long chord windings of class (*I*) with $\frac{N_2}{2p}$ whole, that the only practical conclusion to be drawn is simply as to the inferiority of diametric windings in general, especially when it is remembered that they yield the least amount of damping from the presence of other short-circuited spool sides within the same slots. The more distributed windings may at least be credited with the same amount of damping as is assumed in the table of values of kd under the first heading, although in practice, in order to be on the safe side, one may be willing to ignore any such action entirely in the calculation of L_s.

11. *Practical importance of Ls.*

The importance of the quantity of L_s to the designer turns upon its appearance in the expression $\frac{R_1 T}{L_s}$, where R_1 is the contact resistance of one set of brushes.¶ That the relation $\frac{R_1 T}{L_s} > 1$ is a necessary condition for sparklessness may now be regarded as generally accepted, and more recently Prof. Arnold has further elaborated (‖‖) the special case with carbon brushes. With a rapidly-varying current having a given effective current-density $s_{u\,eff}$ the specific contact resistance, Rk for each momentary value of the current density, s_{ux} may, with carbon brushes, be divided into two portions, or $Rk = Rw + \frac{eu}{s_{ux}}$; the one portion, Rw, remains constant and is independent of the momentary current density, while the other portion varies inversely thereto. The variable part varies in the wrong direction and cancels itself out so that it in no way assists in suppressing sparking. The corrective action of the contact resistance is thus solely dependent upon Rw, and in the calculation of R_1 it is this value, Rw that must be used rather than the entire value, Rk. But even the portion Rw varies in the wrong way when the effective current density is altered, being higher when the effective current density is low, and lower when the effective current density is high and the equalizing action of the brush resistance is most urgently needed; in fact, it varies inversely with the effective current density, or $Rw = \frac{Pw}{s_{u\,eff}}$. Thus Pw or the loss of volts over Rw is practically a constant quantity, although varying between the limits of 0.7 to 1.1 volts with different kinds of carbon of varying hardness.

The relation $\frac{R_1 T}{L_s} > 1$ can now be expressed in a form that brings

¶ Apart from certain qualifications when the less common forms of armature winding are in question.

‖‖ Die Gleichstrommaschine, chap. xix, § 94.

it into line with the previous expressions of paragraph 9. If f_u = the form factor of the curve of the average current density in the brush, the average value for each point along its surface of contact being plotted in relation to a horizontal axis of space, i. e., $f_u = \frac{s_{u\,eff}}{s_u}$, and if F_u is the total area of one set of brushes, $R_1 = \frac{Rw}{F_u}$

$$= \frac{Pw}{F_u . s_{u\,eff}} = \frac{Pw}{F_u . s_u . f_u} = \frac{Pw}{2\,\mathcal{J} . f_u}.$$

Thence by a simple transposition, $\frac{2\,\mathcal{J} L_s}{T} < \frac{Pw}{f_u}$

$$< \frac{0.7 \text{ to } 1.1}{f_u} \text{ volts.}$$

Yet, while this relation is of primary importance in the mathematical theory of commutation, its practical significance to the designer does not appear to the writer to be so great, owing to the fact that if the $L + \Sigma M$ is not too high for the first condition of paragraph 9, the fulfilment of the second condition is almost invariably obtained without any difficulty, at least with chord as opposed to diametric windings. The final result, therefore, of our examination is to emphasize the necessity for the accurate calculation of $L + \Sigma M$ as *the* important quantity to the designer in the problem of commutation.

Motor Driven Machinery.

BY FRANK B. KLEINHANS.

THE subject of motor-driven machinery is brought more or less before every machine builder. If all shops used one standard construction of motors, the problem would be made very much more simple. But we are obliged to equip our machines to accommodate motors of a dozen or more different designs, some being constant-current machines with no variation in the field, and others with a slight variation in the field. Then there are the alternating-current motors which run at a speed that cannot be changed, and motors with a two-to-one variation, a three or four-to-one variation with multivoltage, and finally motors with a variation of seven or eight-to-one, like the Bullock, also a multivoltage motor. The type of motor, therefore, determines the construction which shall be used in applying a motor to the tool. If we were to equip a lathe with a multivoltage motor with the least possible change, we would find that the general run of lathes would require a speed variation of from six to eight-to-one. If the motor which we are to use for the machine had a less range than would be obtained from the cone, an entirely different construction must be schemed out for the motor drive. Here lies the source of all the trouble.

There are cases where the expense of the design, the necessary gearing and changes to accommodate things are such that the motor-driven part of the machine, including the motor, is almost as great as the cost of the machine itself. This the customer is unwilling to pay for. Of course, this is only true of the small-size machines. On account of this enormous expense, which is altogether out of proportion with the price of the machine proper, it is inadvisable to have independent motor-drives on every machine throughout the shop. By the use of a good variable-speed countershaft, we can readily obtain the range of speed which is necessary for the lathes, or any other machine, and we can, therefore, use a standard machine without any alteration whatever. The machines can then be grouped together in sections and driven from a short line shaft by a motor. Such an arrangement would be much more economical than the individual drive for the reason that there are many times when the machine is used for polishing, light drilling, etc., when the power used is a very small percentage of that which would be required to drive the machine with an individual motor.

We would thus have an individual motor running a great part of the time with a very inefficient load, whereas when a group of these machines are all driven from the same motor, there is a tendency to even up things for the reason that the no-load machine and the full-load machine are both on the same motor. On the large-sized machines, however—say those machines which would require 5 hp or upwards to drive them—the mounting of individual motors on the machine is a small item of expense in comparison with the total cost of the machine.

Of all designs for motor drives there is perhaps none that is as difficult in connection with changing speeds as that for the constant-speed motor. We are obliged to have a sufficient number of runs of gearing that the gap from one speed to the other may not be too great. When a great amount of power is transmitted and when gears run at a high rate of speed, it is inadvisable to have several different changes of gearing running all the time. We are thus obliged to slip the gears out of mesh, which requires us to stop the machine and then pull the gears around so as to be able to thread the teeth through each other. This takes time and the operator will frequently run at a slow speed instead of taking the trouble to

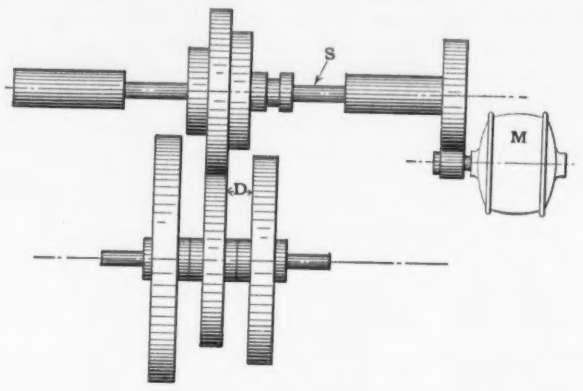


FIG. 1.—DIAGRAM OF GEARING.

make the change. A combination of a sliding gear and an eccentric makes this matter very simple.

Referring to Fig. 1, we have a constant-speed motor, *M*, driving the shaft, *S*, which carries three changes of gearing. In order to shift from one run to the other, the eccentric is first thrown out and then the gears are shifted and the eccentric is thrown in. This can be done by simply slowing down the machine. This construction is very readily applied to a lathe, as the eccentric on the back gear shaft is already a part of the machine. The shifter arm is shown in Fig. 2. The clutch block, *C*, is made of cold-rolled steel and is provided with a spring, *S*, which pushes the block out. As the eccentric is thrown in and out this spring pushes the clutch block out against the clutch spool so as always to be engaged with it.

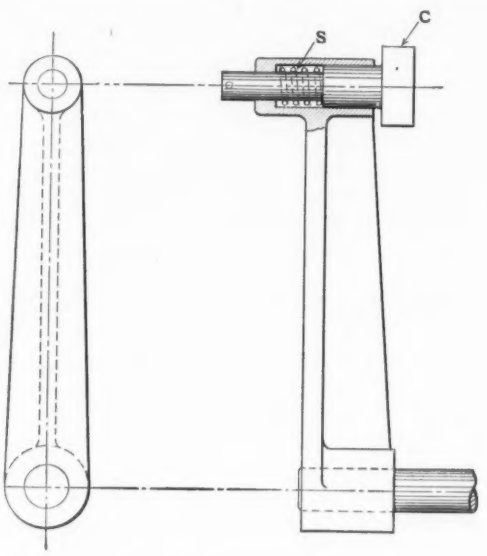


FIG. 2.—SHIFTER ARM.

Another advantage of this double method of shifting the gears is that we only require a little more than once the face of the gears at *D* instead of a little more than twice the face, as would be the case if the eccentric were not used; for we must have one gear disengaged when sliding the gears before the other gear enters. We are thus enabled to get the gearing in a great deal less space, which is a decided advantage in many cases.

The connection for the motor to the machine can be made either through gearing or silent chain. If a silent chain is used, provision

should be made for taking up the slack in the chain. This is especially true when the line between the motor center at the gear center is vertical. When the connection is made through gearing direct to the machine, raw hide should be used to deaden the noise.

In Fig. 3 is shown a raw hide pinion on the motor shaft, *S*. These pinions should all be shrouded, and the shrouds should be held together with screws, *A*, with the head on the outside so that when the pinion dries out the slack can be taken up. The pinion should be provided with a key and a headless pointed set screw, *P*, to keep it from shifting on the shaft. We should have one or more pinions, *P*, or keys, to keep the shrouds from twisting around. Many raw hide pinions have failed on account of the shroud slipping around and the pressure coming on one corner of the tooth, thus wearing it away rapidly. The face, *F*, of the gear should be made 50 per cent. wider than would be required for strength, according to the gear formulas, the teeth, of course, remaining the same per inch. Whenever an idler is used in order to get from the motor shaft over to the machine—and this construction must often be resorted to—the idler, as at *I*, Fig. 4, should be made of raw hide, the pinion, *P*, and the gear, *G*, being either made of cast iron or steel, as desired.

When constant-speed motors are used to drive a lathe, a thread indicator should be provided to avoid the necessity of reversing the motor. When a multivoltage motor is used, and too much can-

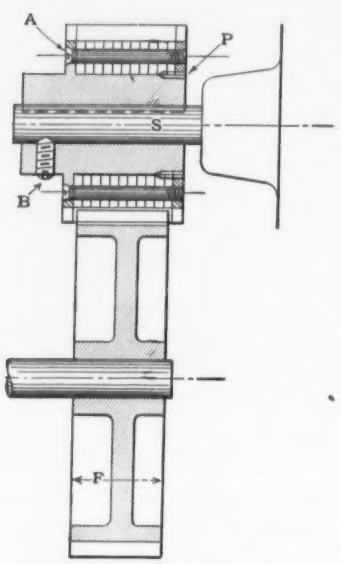


FIG. 3.—CROSS SECTION OF GEAR AND PINION.

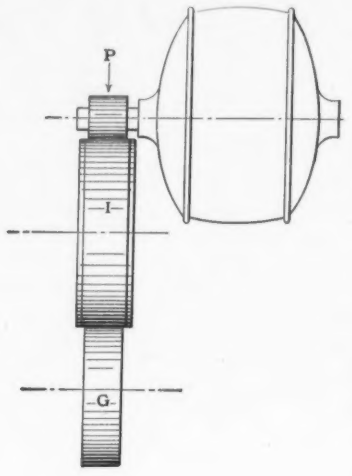


FIG. 4.—IDLER WHEEL.

not be said in regard to the utility of this style of motor, a spline shaft should be arranged so that the operator can have a comfortable handle always near his work. In using these motors it must be remembered that the multivoltage motor for certain horse-power has a much larger frame and is really a larger motor. This is necessary in order to give us the required power as the speed changes.

The Economic Function and Status of the Telephone.

Before the Insurance Society of New York, Mr. C. J. H. Woodbury, M.E., of the engineering department of the American Telephone & Telegraph Company, delivered recently an admirable address on the modern telephone system, characterized not only by popular treatment but by philosophic insight and by great precision of interesting detail. As might be expected, in view of the nature of his audience, Mr. Woodbury enlarged upon the safeguarding features of the system, describing the various fuses and arresters, in principle and operation—protectors so sensitive that they would shut out from the telephone the battery currents used in telegraphy, and keep away heavy currents from delicate wires, some of which are so fine that 3.9 miles would barely weigh a pound.

As to circuits, he pointed to the gain from the use of hard-drawn copper wire, due to Mr. T. B. Doolittle; the substitution of such wire for iron wire having increased the limit of telephonic conversation under equivalent conditions about four times. As to underground circuits, "in the modern cable one mile of underground is the equivalent of 28 miles of overhead copper wire 1/6 in. in diameter, or 12½ miles of overhead copper wire 1/10 of an in. diameter." The use of such circuits between 7 P.M. and 7 A.M., or at night, was slightly over 1 per cent. of the calls in the whole 24 hours. The total amount of telephone line of the Bell system throughout the United States averages 3.29 miles per line to each telephone instrument, and excluding the long-distance lines, 55 per cent. of the wire is underground. When one person calls up another by telephone, the average line plant at his disposal is 6.58 miles.

Mr. Woodbury next discussed the switchboard and its evolution up to the present common battery, lamp signal type, and he explained also the features of measured service and toll line operation. As to increase of cost of board with size, so often misunderstood by critics, who think the board and service ought to get cheaper as they get bigger, he noted the increase of cost in bridges with size of span and in pipe organs with size and number of pipes. The mechanical intricacy of the modern switchboard might well be appreciated from the fact that it requires as long to make and install a large switchboard as to build and equip a merchantman, the time being from one to over two years. The cost of an exchange plant may reach $1,200 per linear foot of length for the larger boards, and perhaps half that cost per foot for a switchboard adequate for a city of 50,000 inhabitants. And such boards were only a small part of the cost of a system.

With regard to operation, the result of systematic training in New York City, with the new apparatus, had been to reduce the time of making complete local connections during the past five years 3.9 seconds, a short space of time to any one unless waiting for a gun to go off; but this small amount had, when applied to all the Bell telephone connections in the United States, amounted to 10,098 hours a day, saved to subscribers, or 3.9 years in 8-hour days. The saving of time in disconnection largely owing to use of lights instead of shutters, releases the lines at the end of a talk 3⅔ times as rapidly as before. The Bell network provided for 9,322,951 calls per day, or nearly 2,500 per year per telephone; and as each telephone receives that number, the telephone averages 5,000 uses per year. It was little wonder the line was sometimes "busy," in spite of the resort to duplicate lines and private branch exchanges. In New York City the number of operators in private exchanges was twice that of those in the telephone centrals. The interruptions of service were very slight and chiefly from changes made at night. In New York City the interruption from all causes was 1 h. 21 min. per year, generally without the subscriber's knowledge. Mr. Woodbury disclaimed any ability to determine why people subscribed for a telephone, and indicated the difficulties of predicating the number of telephones on other sociological or economic data. It was true that when roads were bad, toll line telephone traffic was good. A hilly town used far more telephones than one in the plain. A warm climate or hot weather made for telephone use more than did a cool atmosphere; all summing up in the injunction: "Don't travel—talk."

When a person uses the long-distance telephone, a large amount of property is at his exclusive service. In speaking from Boston to Omaha, as one business firm does every morning, the value of apparatus at their disposal at the present price of copper is over $283,000; while the service of nine operators en route is required. The weight of the copper is 1,131,000 pounds, or 565½ tons. There was incidentally the cost of fire protection of all the apparatus, and most modern exchanges had been built specially to afford resistance to fire and fire hazards. The fire losses on these properties had, therefore, been nominal. Those of the New York Telephone Company since its incorporation had been less than 5¼ per cent. of the premiums.

Mr. Woodbury closed by instancing the varied uses to which the telephone service is now put, outside regular exchange work, as in connecting steamships with shore, railroad trains, trolley cars, wrecking cars on steam roads, etc. The cars of the funicular road on Mount Tom, Holyoke, Mass., are equipped with telephones that have sliding contacts on wires at the side of the track, for the motormen. The board of directors of a Chicago corporation with members also in Milwaukee, St. Paul and Detroit has meetings, with these men at their telephones. At presidential conventions the proceedings are telephoned all over the country. Oaths are administered by telephone, and love made the same way. At Muncie, Ind., a young lady dismissed her swain. In response to his plea over the telephone to be allowed to call again, she replied by firing three revolver shots into her own telephone transmitter—which indicated a certain prudence on the part of her interlocutor.

Methods of Signaling and Operating in Telephone Exchanges.—II.

BY KEMPSTER B. MILLER AND CHARLES S. WINSTON.

II. CONNECTION BETWEEN TWO SUBSCRIBERS IN DIFFERENT COMMON BATTERY OFFICES.

WHEN a telephone exchange has two or more offices, provision is made so that a subscriber in one office may be connected with a subscriber in any other office. For the purpose of making these connections, trunk lines extending between the offices are provided. The outgoing ends of these trunk lines end in jacks multipled throughout the subscriber's sections of one office, and the incoming ends terminate in plugs and lamps located on the keyboard of a particular position or positions at another office. In order to provide means for making connections, both from and to the subscribers of any office each office is provided with both incoming and outgoing trunk lines, the outgoing lines at one office being incoming lines at the other. The trunk lines are therefore used for "oneway" service only. By the arrangement mentioned a calling subscriber desiring a connection with a subscriber in a distant office is always connected with the outgoing end of a trunk line leading to that office, at which the called-for subscriber is then connected with the incoming end of the same trunk line.

Those operators who sit at the regular positions of the board at which the subscribers' lines terminate ("subscribers," or *A* positions) are termed "subscribers'" operators or *A* operators. The incoming trunk lines are terminated in plugs at positions known as "trunk" position or *B* positions, and the operators who handle the incoming ends of these trunk lines are called "trunk" or *B* operators.

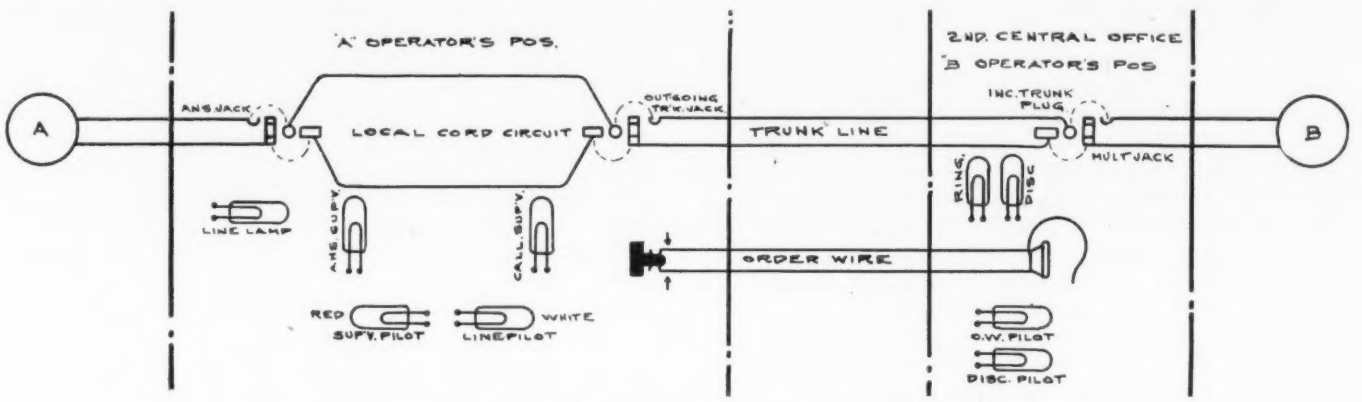


FIG. 3.—CONNECTION THROUGH TWO COMMON BATTERY OFFICES.

These operators have, as a rule, no means of listening in on a conversation. Each trunk operator, however, is provided with a telephone set, to which lines from other offices are connected so that the subscriber's operators at these distant offices can, by pressing a key, known as an order wire key, converse with any trunk operator. Each subscriber's operator has at her position a certain number of order wire keys which are connected to lines, used for order purposes only, multipled through all of the regular subscriber's positions. By means of these she may give instructions to the trunk operator as to the connection desired.

When a subscriber (subscriber *A*, Fig. 3) whose line terminates at one office desires to converse with a second subscriber (subscriber *B*) who is connected with a second office, he will remove his telephone from its hook, thus lighting the line and pilot lamps at the switchboard of his office in the ordinary manner. The subscriber's operator will answer by inserting the answering plug of one of her pairs of cords into the corresponding jack, and will find out from the calling subscriber the number of the line in the second office, with which he desires to be connected. She will then press a key in an order-wire circuit, which terminates in the telephone set of a trunk operator at the desired office, and tell this operator the number of the line with which one of her subscribers desires to be connected. The trunk operator will then designate to the subscriber's operator, over the order-wire circuit, the trunk line which is to be used in making the connection, and with the plug of this trunk line test the multiple jack of the desired line. If, upon testing, the operator finds that the called-for line is not busy, she will insert the trunk plug into the multiple jack. At the same time the subscriber's operator at the first office will insert the calling plug associated with the answering plug, which is in the answering jack of the calling line, into a multiple jack of the trunk line designated by the trunk operator. The calling supervisory lamp at the subscriber's operator's position will light in the same manner as it does when the calling plug is inserted directly into a subscriber's multiple jack.

As subscriber's bells are always rung by operators at the office in which their lines terminate, the subscriber's operators are instructed not to ring when a connection is made over a trunk line, and the ringing is done by the trunk operator. For this purpose the cord circuits in which the incoming trunk lines terminate are provided with ringing keys of the same type as those used on the calling cords of the subscriber's operators.

Associated with each incoming trunk circuit there are two lamps; one known as the "ringing" lamp, which lights as soon as the trunk plug is inserted into the jack, and remains lighted until the called-for subscriber answers, when it is extinguished and cannot be relighted until the plug is removed from the jack. At the same time that this lamp goes out the calling supervisory lamp of one of the subscriber's operator's cord at the distant office is extinguished. The information is thus conveyed to both operators simultaneously that the called-for subscriber has responded.

The second lamp associated with each incoming trunk circuit, known as the "disconnect" lamp, lights after the conversation has been finished and the connection has been taken down by the subscriber's operator at the originating office. This latter lamp also serves as a guard lamp to prevent mistakes in the selection of trunks by the operators. In the Kellogg system this lamp will light if the trunk operator inserts the trunk plug into a jack of the called subscriber before the subscriber's operator at the originating office inserts a calling plug into the outgoing trunk jack, or, if the subscriber's operator at the originating office inserts the calling plug into the outgoing trunk jack before the incoming trunk plug is inserted into the multiple jack of the called subscriber's line. This feature of the circuit serves as a guard at both offices against misunderstandings on the part of the operators in regard to the trunk line to be used, and therefore against mistakes in establishing connections at either end.

As the trunk operator and subscriber's operator ordinarily establish connection practically simultaneously, the disconnect lamp seldom does more than flash when the connection is put up. If, however, this lamp lights and continues so at the beginning of a connection, it shows that one of the operators has probably used the wrong trunk. Seeing this lamp remain lighted, the trunk operator would obey its signal; that is, pull down the connection. This would leave the calling subscriber without his connection, and the connection would soon be ordered up again by the subscriber's operator.

At the end of conversation the calling subscriber will hang up his receiver and thus light the answering supervisory lamp at the offices at which the call originated, no signal whatever being transmitted to the trunk operator. The called subscriber will hang up his receiver and light the calling supervisory lamp also at the originating office. No act on the part of either subscriber will have any effect upon the lamps at the incoming trunk position. The subscriber's operator, who, as seen from the above, has complete charge of the connection after the called subscriber has answered, will take down the answering plug from the answering jack and the calling plug from the outgoing trunk jack. The latter act will light the disconnect

lamp at the incoming trunk position at the distant office, and the trunk operator will remove the trunk plug from the multiple jack.

Thus, it will be seen that there is no instant when either the calling or the called subscriber cannot signal an operator at one of the two offices.

If upon testing with the trunk plug, the trunk operator finds that the called-for line is in use, she will insert this plug into a "busy back" jack, one or more of which are located within easy reach of each position. This jack is constantly connected with a source of interrupted e.m.f., which will place a "tone" on the line. The placing of the trunk plug into the "busy back" jack will also cause the calling supervisory lamp at the subscriber's position at the distant office to flash at regular intervals. The calling subscriber hearing the tone will (if he understands its significance) hang up his receiver, thus lighting the supervisory lamp of the answering plug used in making the connection, and both lamps being thus lighted, the subscriber's operator will pull down the connection as in the case where two local subscribers were connected. If the subscriber does not understand the tone, the *A* operator seeing the rhythmic flashing of the calling supervisory lamp will listen in on the line and inform the subscriber that the line called for is busy.

If, after having rung the subscriber several times, he does not respond, the trunk operator will withdraw the trunk plug from the line jack and insert it into a "don't answer" jack, which will place a different tone from that given by the "busy back" jack on the line, and this will be interpreted by the subscriber or the *A* operator, or both, as meaning that the subscriber does not respond. This feature is used on the Kellogg systems, and some of those supplied by the Western Electric Company.

The trunk system of the Western Electric Company operates in practically the same manner as the Kellogg system described above, but the guard-lamp feature is not carried out to the same extent. In their system, when an incoming trunk plug is inserted into a multiple jack before the calling plug is inserted into the outgoing trunk jack at the distant office, the disconnect lamp will light, but the act of inserting the calling plug into the outgoing trunk jack at the distant exchange previous to inserting the trunk plug, will have no effect upon the disconnect signal at the trunk position. In all other respects, the methods of signaling are identical.

It is customary to arrange, at each incoming trunk position some means of transferring the incoming order-wire calls, in case a trunk operator leaves her position, either momentarily or for a period of considerable length. The scheme which is used by the Kellogg Company is to wire in the telephone set of each trunk operator a two-way key. If this key, at a trunk position, is thrown in one direction and an operator at a distant office presses an order-wire key and attempts to converse with the trunk operator the order will be received by this operator, and at the same time an order-wire pilot lamp will be lighted at this trunk operator's position. However, if the key is thrown in the opposite direction, the order, and pilot lamp signal will be transferred to some other trunk operator's position. If the key at this second position is thrown in one direction the order and pilot lamp signal will be received at this second position, or if thrown in the other direction, it will be transferred to a third position. In this way it is possible for one trunk operator to do all of the incoming trunk business at night, or whenever the number of incoming trunk calls is small. The order-wire pilot lamp is ordinarily wired in a manner similar to that in which the line and supervisory pilot lamps are wired, so that the night alarm will ring whenever the lamp lights, if the night-bell switch is in the proper position.

The Western Electric Company's scheme of transferring order-wire calls, although similar to that described above, is different in some respects. If the subscriber's operator at one office presses an order-wire key, and upon attempting to converse with a trunk operator at a second office, receives no response, she will press a key, called the ring-down key, at the same time that the order-wire key is depressed. This will send current from generator out over the order-wire circuit and throw a relay (which is mechanically similar to the electrical restoring drop of the Western Electric Company), and light a pilot lamp at the trunk position. This pilot lamp will remain lighted until the operator returns to her position and extinguishes it by pressing a key, which sends battery current through the restoring winding of the relay and brings it back to its normal position. This pilot lamp is connected to the night-bell circuit in the same way that the order wire pilot is connected in the Kellogg system. Incoming trunk calls are transferred from one position to another in the Western Electric system in practically the same manner as in the Kellogg system.

In the operation of systems so far described, the ringing of the called subscriber has always been done manually by the *A* operator when no trunk was used in making the connection, or by the *B* operator where connection was made through a trunk.

In some of the exchanges built by the Western Electric Company, and in some of the foreign work of the Kellogg Switchboard and Supply Company, this necessary act of ringing on the part of the *B* operator is partially or entirely eliminated.

This feature is termed automatic ringing. In the system installed by the Kellogg Company in one of the London, England, offices, and, we believe, also installed in some instances by the Western Electric Company, where there are no party lines the *B* or trunk operator has only to plug into the multiple jack of the called subscriber, which act energizes a relay in the cord circuit, which throws ringing current on to the line. This current continues to flow, ringing the bell of the subscriber until he responds, or until the operator removes the plug from the jack. The response of the subscriber, by closing the metallic circuit of the line, trips the ringing relay, and cuts off the ringing current from the line, and allows the circuit to assume its proper relation for talking. Obviously, this method is not adapted without modification for selective signaling on party lines, for no means would be provided for selecting the proper party on a line. Probably, for this reason mainly the Western Electric Company does not ordinarily have the ringing current automatically thrown on the line, this being accomplished by the operator pressing a button (or when party-line ringing is required one of a series of buttons) associated with each cord circuit, which act sets the ringing relay, which establishes the proper connection between the ringing current and the subscriber's line. This relay is tripped automatically by the response of the subscriber, as in the more completely automatic-ringing system described above.

Automatic ringing apparatus has not, so far as we are aware, been applied to the circuits of the *A* or subscribers' operators in this country. This is perfectly practical when there is no trunking work to be done; that is, when there is but one office in the exchange, but where the necessity for trunking exists the consequent complication of the circuits would probably not be warranted by the gain in operative speed.

III. PRIVATE BRANCH EXCHANGE SERVICE.

By "private branch exchange" is meant an exchange complete in itself, in that it is adapted to bring into communication any two subscribers in a comparatively small community, such as that in a business office or factory; and which also affords communication between these subscribers and those of a larger exchange, such as that of a city. It is a *private* exchange because it is individual to the particular institution which it serves. It is a *branch* exchange because it operates in conjunction with and forms a part of a larger exchange. Hence the term private branch exchange.

In nearly all cases a private branch exchange equipment consists of a switchboard of suitable size from which the lines extend to the various branch exchange subscribers, the operation of the exchange within itself being practically the same as that of any ordinary common battery exchange. Connections between a subscriber in the branch exchange and a subscriber in the city exchange are made in the same general manner as between two subscribers in different offices of a city exchange, being through trunk lines extending between the two switchboards. It is customary, however, in order not to confuse the work of the *A* operators in the city exchange, and on account of economy in trunk lines, to use two-way trunks in connecting a private branch switchboard with the larger central office, instead of using one-way trunks, as has already been described, in connecting two central offices in the same exchange.

In order to avoid confusion between the office or offices of the city exchange and that of a private branch exchange, the former will be designated as main offices; it being understood that a private branch office may be connected by trunk lines with any one (usually one only) of the central offices of a city exchange.

Private branch exchange trunk lines usually terminate in the main office multiple switchboard in the same manner as regular subscribers' lines, the trunk lines being provided with an answering jack and lamp on one section of the switchboard and with a multiple jack on each of the sections. With this arrangement the work of the

A operators at the main office is kept standard, they handling incoming or outgoing calls over these trunk lines in exactly the same manner as over a regular subscriber's line.

The trunk lines may terminate at the private branch switchboard in different ways; perhaps the most common arrangement being to terminate each in a plug and a magneto-drop. In some of the latest Bell systems, however, they each terminate at the private branch end in a lamp and jack.

As in other branches of services, the tendency is to have the subscribers' operators at the multiple boards of the city exchanges perform no more special work than is absolutely necessary. For this reason the termination of the private branch exchange trunk lines on the multiple switchboard in exactly the same manner as ordinary subscribers' lines, and the retaining of the same method of operation for these branch trunks as used in the regular lines, is in accordance with good practice.

The facility with which private branch operators may handle connections is not so important as in the case of the regular subscribers' operators, whose work affects more directly the entire exchange. Moreover, the private branch operator is made to take much of the work of obtaining connections herself which would otherwise fall to the subscribers in the private branch exchange. She may be made to do the waiting necessary for the called subscriber to respond without consuming the time of the private branch subscriber who desires the connection. This applies particularly to outgoing calls from the private branch exchange, but her function is not less important with respect to incoming calls from the main exchange subscribers, for she may properly distribute such calls directly to the departments where they can best be attended to, thus relieving the more prominent members of the firm of many calls which would otherwise come to them. The branch exchange operator may, in fact, perform largely the same duties as are often assigned to an office boy, relieving the subscribers of much of their routine work in obtaining connections, and acting as a go-between between the public and the branch exchange subscribers.

It may be said in general that the items of first cost and maintenance in private branch exchange working are of more importance than in perhaps almost any other subsidiary branch of telephone work. Private branch exchange switchboards are, on account of the comparatively few lines they contain, and on account of the amount of apparatus they necessarily employ, found to cost more in proportion than any other types of switchboard, and this expense the operating company naturally wishes to keep as low as possible. Furthermore, private branch exchanges are usually required to give service to the busiest subscribers, whose time is valuable, and reliability of service is therefore of the greatest importance. These boards are usually manipulated by operators not in the employ of the telephone company, but of the firm in whose office the exchange is installed. For this reason the operating company cannot be sure of the boards getting the best attention. All of these points tend to make the factor of simplicity in a private branch exchange equipment carry more weight than might otherwise be the case, and for this reason speed in operation is often sacrificed toward this end.

The fact that the private branch exchange operator is usually in the employ of the subscribing company rather than of the operating company is, on the whole, an undesirable feature, from the standpoint of both companies. This fact is, however, generally recognized by the operating company only, with the result that the subscribing companies continue to employ their own operators.

In Fig. 4 is shown a connection between a private branch exchange subscriber and a regular subscriber, the connection being made through a trunk line ending in a plug at the private branch exchange. A similar connection through a trunk ending in a jack at the private branch exchange is shown in Fig. 5. Each of these figures shows the usual signaling devices at both private branch and main offices.

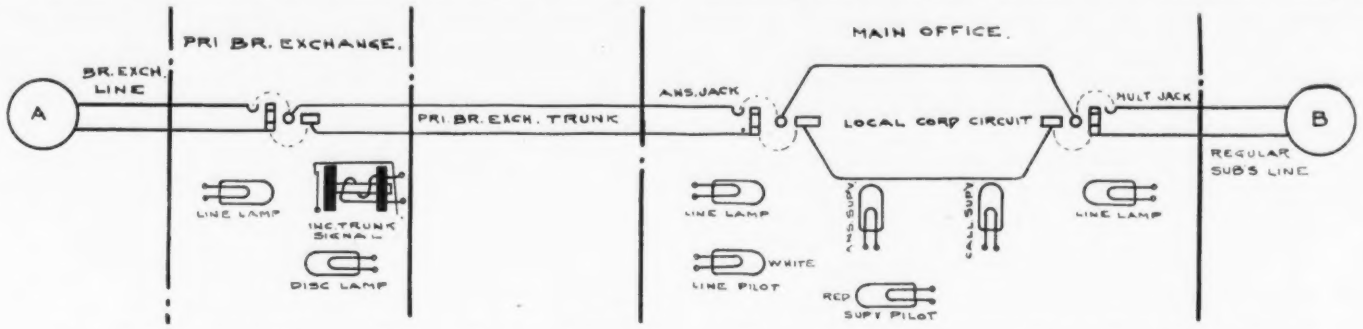


FIG. 4.—CONNECTION BETWEEN PRIVATE BRANCH SUBSCRIBER AND MAIN OFFICE SUBSCRIBER, USING PLUG-ENDED TRUNK.

Referring to these figures the method of operation and signaling in private branch exchanges may be described. For a local connection between any two subscribers in the branch exchange the connection is made and supervised by the branch exchange operator in exactly the same manner as between two subscribers whose lines terminate in the same office in a large exchange. If, however, the subscriber in the branch exchange desires a city connection he will raise his receiver from the hook, and the operator will respond by inserting an answering plug into the jack of his line in the usual manner. Instead of telling the operator the connection desired and waiting for it to be established he will usually tell her to obtain a certain party for him and hang up the receiver. If the system is one such as shown in Fig. 4, where the trunk line terminates in a plug on the private branch exchange board, the operator will call central by closing, in some convenient manner, the metallic circuit of the trunk line, thus lighting the lamp belonging to that trunk-line at the main office. She will also bridge her telephone across the trunk circuit by means of a listening key, and await the response of the main office operator. The subscriber's operator at the main board will answer the call in the usual way, and complete the connection with the line of the subscriber called for. After this subscriber responds, which fact the

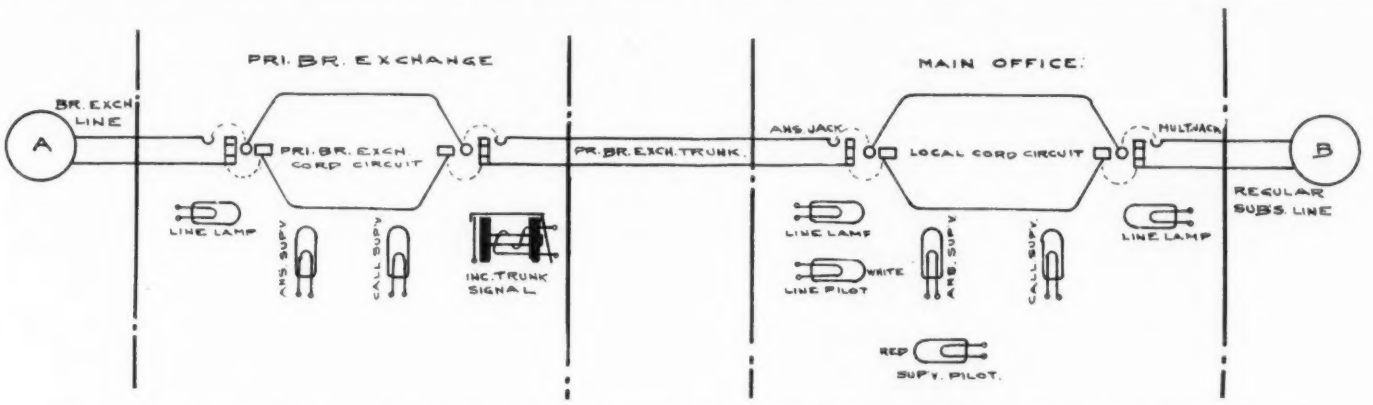


FIG. 5.—CONNECTION BETWEEN PRIVATE BRANCH SUBSCRIBER AND MAIN OFFICE SUBSCRIBER, USING JACK-ENDED TRUNK.

private branch operator ascertains by listening in on the circuit, this operator inserts the plug of the trunk line into the jack of the branch exchange subscriber who originated the call, and by means of a ringing key calls him.

If the private branch exchange employs jack-ended trunks, as in Fig. 5, the operator will answer the calling subscriber with the answering plug, as before, and will, after ascertaining the connection desired, call up the main office by inserting the corresponding plug of the pair into the trunk jack, after which the connection will be completed as just described.

The Central Stations of the United States.

The central station data of the United States, just issued by the United States Census Office, were noted in these pages last week. The bulletin prepared by Mr. W. M. Steuart, the chief statistician, is, indeed, a most interesting and suggestive document, its 51 tables covering every branch of the electric light and power industry. Our previous quotations dealt with the gross figures, the distribution of the stations, and the great gain exhibited by the industry as compared with gas. We may now take up some of the other items brought to account. The first of these deals with the capital account.

Of the 2,049 central electric stations operated under private ownership and controlled by corporations, 747 are operated in connection with gas plants, waterworks, or other industries. In such cases the capital stock and bonds, as a rule, cover the entire interests of the corporation, there being no separate issue for the electric station. This is especially true of a corporation which was originally chartered for the manufacture of gas or the operation of water works, and made no additional issue of stock when the electric station was established. Under these conditions it is impossible to obtain an accurate enumeration of the capital stock or funded debt for electric stations exclusively, and the amounts charged to such stations are estimated. These estimates are based largely upon the income derived from the electric stations as compared with the total income of all interests covered by the capital stock and bonds. The capital stock and bonds reported, therefore, may be accepted as representing the capitalization of the central electric stations. The totals for the United States are summarized in the following table:

CAPITAL STOCK AND FUNDED DEBT—INCORPORATED COMPANIES: 1902.

Total capital stock and funded debt authorized	$743,296,266
Total capital stock and funded debt issued	627,515,875
Capital stock:	
Authorized	435,178,372
Issued	372,951,952
Dividends	6,189,837
Funded debt:	
Authorized	308,117,894
Outstanding	254,563,923
Interest	12,118,740

Capital stock constituted 58.5 per cent. of the total authorized capitalization of the stations operated by incorporated companies, and bonds or funded debt 41.5 per cent. Of the total authorized capital stock $372,951,952, or 85.7 per cent., had been issued and was outstanding at the end of the year covered by the report. Of this amount, $23,871,671, or 6.4 per cent., was preferred stock, and $349,080,281, or 93.6 per cent. common stock. The common stock on which dividends were paid during the year amounted to $126,284,352, or 36.2 per cent. of the total issued. This represents an average rate of 4.4 per cent. on all the common stock which paid dividends. Of the total preferred stock, $12,197,463, or 51.1 per cent. of the amount issued, paid dividends, the average rate being 5.2 per cent. There were, therefore, $222,795,929 of common and $11,674,208 of preferred stock on which no dividends were paid. Only 589 companies reported that dividends were paid on either common or preferred stock. There were 71 companies that reported an issue of preferred stock, and 41 that paid dividends on such stock, while 561 paid dividends on common stock and only 13 paid dividends on both common and preferred stock. Of the 2,049 incorporated companies, 795 paid interest on their bonded indebtedness. The amount of this indebtedness was $250,535,749, and the interest paid was equivalent to an average rate of 4.8 per cent. There were 656 municipal stations that reported an issue of bonds amounting to $11,609,488, and 635 reported that interest amounting to $504,805 was paid on bonds to the value of $11,239,588, or an average of 4.5 per cent. on all bonds paying interest.

The manner in which the expenses are divided up is shown by the following table:

EXPENSES—PRIVATE AND MUNICIPAL STATIONS, AND PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

Items.	Total.	Private stations. Amount.	Per cent.	Municipal stations. Amount.	Per cent.
Total	$68,081,375	$62,835,388	92.3	$5,245,987	7.7
Salaries and wages	20,646,692	18,766,970	90.0	1,879,722	9.1
Supplies, materials and fuel	22,915,932	20,493,641	89.4	2,422,291	10.6
Rents, taxes, insurance and miscellaneous	11,895,206	11,456,037	96.3	439,169	3.7
Interest on bonds	12,623,545	12,118,740	96.0	504,805	4.0

The following table gives an idea how the supply expenditures are divided up:

SUPPLIES AND MATERIALS—PRIVATE AND MUNICIPAL STATIONS, AND PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

Items.	Total.	Private stations.	Municipal stations.	Per cent. In private stations.	Per cent. In municipal stations.
Total cost	$11,280,423	$10,303,956	$976,467	91.3	8.7
Meters:					
Number	27,632	25,739	1,893	93.1	6.9
Cost	$416,994	$390,569	$26,425	93.7	6.3
Motors:					
Number	602	572	30	95.0	5.0
Cost	$30,099	$29,202	$897	97.0	3.0
Transformers:					
Number	13,288	7,843	5,445	59.0	41.0
Cost	$365,028	$326,407	$38,621	89.4	10.6
Incandescent lamps:					
Number	8,839,905	8,399,571	440,334	95.0	5.0
Cost	$1,507,249	$1,426,224	$81,025	94.6	5.4
Incandescent lamp fittings, sockets, etc., cost	$177,236	$154,517	$22,719	87.2	12.8
Carbons for arc lamps:					
Number	94,686,596	82,156,930	12,529,666	86.8	13.2
Cost	$1,051,386	$900,788	$150,598	85.7	14.3
Globes for arc lamps:					
Number	485,073	428,979	56,094	88.4	11.6
Cost	$170,929	$150,509	$20,420	88.1	11.9
Arc lamp repairs, cost	$244,537	$212,231	$32,306	86.8	13.2
Poles or other supports, cost.	$346,587	$319,617	$26,970	92.2	7.8
Wire and cable, cost	$1,152,915	$1,081,380	$71,535	93.8	6.2
Mill supplies (oil, waste, etc.), cost	$712,797	$617,911	$94,886	86.7	13.3
Power purchased, cost	$2,130,759	$2,007,193	$123,566	94.2	5.8
Freight paid, not included in other items	$1,120,363	$939,512	$180,851	83.9	16.1
All other materials, cost	$1,853,544	$1,747,896	$105,648	94.3	5.7

The gross annual income for both private and municipal stations amounted to $85,700,605, and the expenses, including interest on bonds, to $68,081,375. Deducting the expenses from the income leaves an apparent net income of $17,619,230, but this amount should not be accepted as the actual net income because the methods of bookkeeping in use by a number of the central electric stations and the manner of carrying on their business made it impossible to obtain the information necessary to prepare a true income account for the generation and sale of electric current exclusively. For instance, the income from "all other sources" includes amounts derived from wiring houses, sale of lamps, wires and other supplies. In some cases, the stations do considerable mercantile business of this character, but it is impossible to segregate the expenditure so as to show the cost of supplies used, as distinct from those sold. The reports for 380 stations show that free service of some character was furnished to the municipalities in which they are located. This free service consisted of lighting part or all of the public buildings, furnishing a certain number of lamps, or making a discount on the lamps used by the city. Where free service was given, its value was estimated at commercial rates and included in the income. Eighty-nine stations reported that a cash compensation was required for the franchise privilege or that a certain

specified amount or percentage of the gross income was required to be paid yearly. In a few cases the stations were required to pay a special tax. All of these amounts have been included in the total expenses shown.

As to the income, incandescent lighting is a much more important source of income than arc lighting for stations operated under private ownership, but for municipal stations these two sources of income are of nearly equal importance. Of the total, $70,138,147, reported as the income from lighting for both private and municipal stations, $50,368,173, or 71.8 per cent., was derived from lighting private dwellings, office buildings, or other business properties, and $19,769,974, or 28.2 per cent., from lighting streets, parks and public buildings. Of the total amount, $25,481,045, reported as income from arc lighting, $8,460,320, or 33.2 per cent., was from lighting commercial or other private properties, and $17,020,725, or 66.8 per cent., from lighting public places; and of the $44,657,102, reported from incandescent lighting, $47,907,853, or 93.8 per cent., was from commercial or other private, and $2,749,249, or 6.2 per cent., was from public lighting.

There are 136 stations that report the purchase of electric current costing $1,300,925; 71, the purchase of water power costing $210,619; 95, the purchase of steam power costing $296,831; and one, the purchase of power generated by gasoline engines costing $240. There are 85 stations which rent the use of water for the operation of water wheels, paying $322,144 for the same, and a number report amounts aggregating $460,011 as paid for water to generate steam.

The totals given in the table below which show the cost of the various kinds of fuel consumed in each class of stations:

COST OF FUEL—PRIVATE AND MUNICIPAL STATIONS, AND PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

Items.	Total.	Private stations. Amount.	Private stations. Per cent.	Municipal stations. Amount.	Municipal stations. Per cent.
Total	$11,635,509	$10,189,685	87.6	$1,445,824	12.4
Coal	9,943,125	8,749,394	88.0	1,193,731	12.0
Crude petroleum	721,838	700,136	97.0	21,702	3.0
Natural gas	254,269	220,460	86.7	33,809	13.3
Artificial gas	28,654	20,135	70.3	8,519	29.7
Other fuel	687,623	499,560	72.7	188,063	27.3

The prominence of crude petroleum will be noted, but its consumption was localized, $515,820 being the value of that used in California and $128,087 the value of that used in Texas.

The pay roll is, of course, a large item. There are 6,996 salaried officials and clerks employed by the central electric stations, receiving $5,663,580 as salaries. Of this number 3,016, or 43.1 per cent., are clerks, who receive $1,716,831, or 30.3 per cent. of the total salaries. The stations operated under private ownership employ 6,046 officials and clerks, or 86.4 per cent. of the total, and those under municipal control, 950, or 13.6 per cent. The salaries paid in the private stations amount to $5,206,199, or 91.9 per cent., and in the municipal stations to $457,381, or 8.1 per cent. of the total. The stations operated under private ownership give employment to 91.3 per cent. of the total number of clerks and pay 96.2 per cent. of the total salaries paid to clerks, as compared with 8.7 and 3.8 per cent., respectively, for municipal stations.

The table below summarizes the totals for the average number and total wages of wage-earners reported for both private and municipal stations and shows the proportion in each class of stations:

AVERAGE NUMBER OF WAGE EARNERS AND TOTAL WAGES—PRIVATE AND MUNICIPAL STATIONS, AND PERCENTAGE EACH CLASS IS OF TOTAL: 1902.

Occupations.	Total.	Private stations.	Municipal stations.	Per cent. In private stations.	Per cent. In municipal stations.
Total:					
Average number	23,330	20,863	2,467	89.4	10.6
Wages	$14,983,112	$13,560,771	$1,422,341	90.5	9.5
Foremen—					
Average number	1,000	943	57	94.3	5.7
Wages	$953,738	$910,972	$42,766	95.5	4.5
Inspectors—					
Average number	571	546	25	95.6	4.4
Wages	$415,904	$397,983	$17,921	95.7	4.3
Engineers—					
Average number	4,587	3,743	844	81.6	18.4
Wages	$3,259,870	$2,721,127	$538,743	83.5	16.5
Firemen—					
Average number	3,456	2,951	505	85.4	14.6
Wages	$1,963,465	$1,717,149	$246,316	87.5	12.5
Dynamos and switchboard men—					
Average number	1,978	1,872	106	94.6	5.4
Wages	$1,351,676	$1,286,065	$65,611	95.1	4.9
Linemen—					
Average number	4,217	3,868	349	91.7	8.3
Wages	$2,710,841	$2,510,269	$200,572	92.6	7.4
Mechanics—					
Average number	1,057	1,009	48	95.5	4.5
Wages	$796,355	$768,694	$27,661	96.5	3.5
Lamp trimmers—					
Average number	2,637	2,318	319	87.9	12.1
Wages	$1,654,462	$1,460,046	$194,416	88.2	11.8
All other employees—					
Average number	3,827	3,613	214	94.4	5.6
Wages	$1,876,801	$1,788,466	$88,335	95.3	4.7

As to the wage earners, it appears that for all classes taken together the prevailing rate of wages is from $1.50 to $2.24 per day, 9,783 wage-earners, or 51.8 per cent. of the total, being paid at this rate. It appears that 13,489 wage-earners, or more than two-thirds of the total number, receive from $1.50 to $2.74 per day. More than one-half of the engineers receive from $1.50 to $2.49 per day, and more than one-half of the firemen receive from $1.50 to $2.24 per day.

Annual Meeting of American Society of Mechanical Engineers.

The annual meeting of the American Society of Mechanical Engineers was held last week at the headquarters in New York City, with an attendance registering in the vicinity of 800. The following were elected officers: President, Ambrose Swasey, of Cleveland. Vice-presidents—O. S. Jacobus, of Hoboken; M. L. Holman, of St. Louis; A. Mattice, of Pittsburg. Treasurer, William H. Wiley; secretary, Frederick R. Hutton, Columbia University. Members of Council—George J. Rockwood, of Worcester; John W. Lieb, of New York, and W. J. Keep, of Detroit. During the week the members of the society were guests of the Edison Company and Interborough Rapid Transit Company in a tour of inspection of the East Side power houses. A meeting was also held at the Stevens Institute of Technology, where Dr. Hans Goldschmidt gave an experimental lecture on "thermit." A crowded reception took place on Thursday night at Sherry's. The annual address of Mr. J. M. Dodge as president was "The Money Value of Technical Training."

Among the papers read at the meeting was one by Mr. Frank B. Perry, of Boston, Mass., entitled, "A Method for Determining Rates and Prices for Electric Power." Mr. Perry criticised the step-rate system, which is illustrated by the example given in the paper, as follows: A uniform rate for use of energy of from 1,800 to not more than 2,160 kw; a smaller rate from 2,160 to 2,520 kw; a still smaller rate from 2,520 to 2,700 kw, and a minimum rate for all in excess of 2,700 kw, all the rates in the illustration given being based on the use of 3,000 hours per annum. The inconsistency of this method is pointed out, one illustration showing that 2,260 kw cost the same as 2,160 kw. With such a method a customer might install a few extra machines that would not only serve to increase his product, but would also be the means of diminishing his bill; as an extreme case, the use of one additional kilowatt would bring about this result.

As a substitute for this method, Mr. Perry recommended that a curve representing rates be plotted, and that a chart containing this curve be embodied in the contract for electric power. The paper gives an algebraic method for determining such a curve, based upon an arithmetical progression, which reduces the cost of unit power as the quantity of power taken increases.

Mr. Benjamin T. Allen, of Harrisburg, Pa., read a paper entitled "The Construction and Efficiency of a Fleming Four-Valve Engine Directly-Connected to a 400-kw Generator." The engine is of the tandem-compound type of a normal capacity of 400 hp at a speed of 150 r.p.m., with 150 pounds pressure on the throttle and 26 in. of vacuum. No steam jackets are used, but a reheating receiver is

placed in the steam passage between the two cylinders. Steam is admitted to the high-pressure cylinder through triple valves of the Corliss type working in chilled iron bushings, the governing being accomplished by a centrally-balanced inertia shaft or wheel governor. The exhaust valves of both cylinders are of the Corliss type operated by a single eccentric through the medium of a peculiar arrangement of rocker arms and bell cranks. The main feature of the engine is an improved form of cut-off, by means of which a satisfactory amount of acceleration can be given to the valves at the points of admission to the cut-off by means of angular motion only, the gear being unencumbered by elaborate cut-off devices.

Following are the steam consumptions found on test: ⅙ load, 14.42 pounds of steam per indicated hp per hour, including quantity used in reheating; at ⅝ load, 13.59 pounds of steam; at 7/10 load, 12.33 pounds of steam; at full load, 12.66 pounds of steam; at 10 per cent. overload, 12.73 pounds of steam. Among the conclusions of the paper are that the dash-pots or other accelerated cut-off devices used in Corliss engine practice are unnecessary complications and unwarranted; that the centrally-balanced direct-connecting fly-wheel device serves its purpose to better advantage than an indirect fly-wheel governor; and that there is better warrant for shorter strokes and moderately high speeds than for longer strokes and lower speeds, notwithstanding the element of clearances.

Mr. C. H. Morgan, of Worcester, Mass., in a paper described a gas engine of the "beam" type, which operates on the two-cycle principle, with an explosion at every downward stroke of the piston. Two compressors, one for gas and one for air, furnish the engine with its charges of gas and air, and provide air for scavangering. The exhaust is through ports in the cylinders which are uncovered by the piston at the end of its downward stroke, thus avoiding the use of water cooling exhaust valves and the mechanism required to operate them. The engine can also be operated on the four-cycle system by slight changes. This type of engine allows the cylinder to be placed upright, and the balancing of the pistons and their connecting rods, while the cylinder walls are subjected to much less pressure from the pistons, thus reducing the friction to a minimum. The description given in the paper is very inadequate and is confused with a description of another type of gas engine.

The Efficiency of Modern Telephone Equipment.

Mr. M. A. Edson read a paper ,with the above title before the December meeting of the Chicago Electrical Association, in which he considered the subject from the technical, engineering and operating standpoint. As to the increase of actual efficiency for purely conversational purposes during the past 20 years, it is stated that the local transmission is only a little better, but the long distance transmission is greatly improved, not so much in any one part, but as a whole, the increase being 50 per cent. in the line and 20 per cent. in the transmitter.

Taking up the subject of transmitters and receivers, it is said that a frequency of 125 to 150 cycles per second should be used, and the most common constant is 750; but when the frequency is raised to 1,200 some phenomena develop in the iron which, if it occurred at a lower frequency, would seriously interfere with transmission efficiency. Fortunately there are only a few singers that can reach a note as high as 1,100, and experiments made at these frequencies (750 to 1,200) are more interesting than useful.

The general tendency of late years is toward transmitters having a low fundamental note, as such transmitters will give greater volume and rate of variation of the primary current per unit of sound energy; lower fundamentals, also, lessen the tendency of the transmitter to amplify certain tones which are near that of the diaphragm. From recent tests it appears that the transmitter changes sound energy into electrical undulations at an efficiency of 50 per cent. in common battery plants and 75 per cent. in local battery. In common battery the efficiency is still further reduced if the loss in the line is considered, which should be the case as it is a part of the primary circuit. These figures are only for the transmitter and do not include the induction coil or other inductive devices.

An uncertain element in the efficiency of the common battery transmitter is the distance from the exchange. It is evident that the greater distance from the exchange means less current, as it is not the modern practice to vary the battery or resistance for different lengths of line. A consequence is that an instrument in the exchange building receives .3 ampere through the transmitter and another through four miles of cable receives one-hundredth .01 ampere, which is about as far as it is safe to go without repeating coils and trunk lines. The average limit is usually set at 350 ohms of line for 24 and 40 volt systems. The line efficiency at two miles from the exchange is 80 and may go as high as 90 for common-battery systems, but for local battery the line is used only for the high voltage variable telephone current and is higher. The average value is 95 per cent. for copper metallic circuits aerial and 85 for standard underground cable.

The efficiency of the power plant in exchanges of from 1,000 to 5,000 subscribers is about as follows: Motor-generator combination, 67.5 per cent.; charging mains, 94.3 per cent.; motor-generator and battery leads, 63.5 per cent.; batteries, 72 per cent. The percentage of total energy delivered to switchboards is thus about 52 per cent. The ringing dynamotors have a 24-hour efficiency of 40 per cent. in the general way they are operated with lamps in the ringing circuits.

1—Subscriber takes receiver off hook. 2—Subscriber's individual signal lights up above pilot lamp, involving a double operation as the relay must first make the contact and the heating of the lamp filament a second. 3—Operator inserts answering plug. This also involves three movements from a military point of view, pick up plug, locate jack, insert plug. 4—Operator sets listening key. 5—Operator asks number. 6—Operator gives number. 7—Operator repeats number. 8—Operator picks up plug, locates jack in multiple. 9—Operator tests for busy. 10—Operator inserts plug. 11—Operator rings called subscriber. 12—Operator restores listening key. 13—Operator notes when called subscriber's lamp goes out in cord circuit. 14—Called subscriber answers. 15—Called subscriber hangs up receiver. 16—Connecting cord lamp lights. 17—Calling subscriber hangs up receiver. 18—Operator removes answering plug. 19—Operator removes calling plug.

In the case of a route trunk to a separate exchange, the operations up to and including (7) are identical, and then proceed as follows: 8—Operator selects order wire key. 9—Operator gives order to incoming trunk operator. 10—Incoming trunk operator repeats number. 11—Incoming trunk operator gives trunk number. 12—First operator picks up plug, locates trunk jack and inserts plug. 13—Incoming trunk operator tests line of called subscriber for busy. 14—Incoming trunk operator inserts incoming trunk plug in called subscriber's jack. 15—Incoming trunk operator sets automatic ringing key. 16—Automatic key rings subscriber. 17—Called subscriber takes up receiver and restores key automatically. 18—Calling subscriber hangs up receiver. 19—Supervisory lamp at first operator's position lights up. 20—Called subscriber hangs up receiver. 21—Second supervisory lamp lights up. 22—First operator pulls out plugs. 23—Disconnect lamp on incoming trunk cord lights up. 24—Incoming trunk operator pulls out trunk plug. In all manual boards there is very little variation in this cycle of operations. Visual mechanical signals are used instead of relays, and lamps and different methods of trunk operation are devised without materially increasing the efficiency. The efficiency of operators as a part of the system is one of the most variable quantities with which to deal in the manual system. One operator may work eight hours at an efficiency of 80 per cent. This is based on the principle that the operator has 100 per cent. of work to perform, and 80 per cent. of the work is done correctly and 20 per cent. is unnecessary errors and delay. This seems reasonable when it is considered that 20 per cent. of the calls in a manual central energy office is lost in various ways at the switchboard. In some recent tests on exchanges with a modern equipment, a variation in the work of each operator for the same period of eight hours shows 200 calls per hour and 18 seconds per connection, and another operator at the same time 100 calls on 36 seconds per call.

Farmers Lose to Swindlers.

The "lightning-rod" game in a new guise is being used among farmers of western Lake County, Ill. An agent secures a contract for equipping house and barns with electric lights for $65, as the farmer believes. Another agent comes to "take measurements," as he says, and calls the victim's attention to the fact that the price is $65 for each light. The farmer usually pays from $15 to $50 for a release of the document.

Recent Electrochemical Developments.

FURNACE PROCESSES.

A patent granted on December 1 to Mr. J. C. T. Kessmeier, of Washington, Pa., refers to the casting of glass articles. For this purpose it is necessary to use glass in a state of extreme fluidity and this condition is produced by means of electric heating. The material to be made into glass is first placed in a furnace which is heated from the outside by means of burning fuel. When melted it flows off through an exit tube, through the walls of which pass two carbon electrodes. In its molten condition the glass is an electric conductor and the current passing through it superheats it to a very high degree, say 3500° F., or more. It is then run into the moulds in which it is to be cast. It would be interesting to know whether electrolytic effects are observed when the current passes through the glass, but the patent is silent on this point.

Two patents granted to Dr. F. J. Machalske, of Brooklyn, N. Y., relate to further developments of his process of producing carbon chlorides and silicon, which has already been noticed in these columns. In one patent the inventor brings about a reaction between a chloride of silicon, usually the tetrachloride, and a carbon compound such as carbon disulphide or methane, in the electric furnace. The silicon and carbon interchange and the resulting carbon chloride is driven off and condensed. The second patent relates to the production of silicon chlorides used as starting material in the first process. He heats in the electric furnace a charge of material containing silicon and chlorine—for example, a mixture of silica and an alkali chloride. The different chlorides of silicon may be produced by suitably varying the proportions of the ingredients of the charge. The inventor does not mention carborundum, although he evidently has it in mind.

ELECTROLYTIC PROCESSES.

The Castner process for producing metallic sodium by electrolysis of fused sodium hydroxide is well known and is operated on a commercial scale. A process for producing sodium patented by Mr. T. Ewan, of Glasgow, Scotland, appears to differ only in details from the Castner process. The porous diaphragm for which Castner uses a screen or gauze is made by Ewan of alumina or of sodium aluminate or of mixtures of these substances. In order to evaporate the water, which is said to be formed at the anode, he passes a current of air over or through the electrolyte in the anode compartment. Nothing is said concerning the temperature, which is known to be a deciding factor for the success of the process.

A patent granted to Dr. H. Paweck, of Vienna, refers to a method of electrolytically refining zinc and depositing thick layers of zinc on iron or other metals. The novelty lies in the constitution of the electrolyte, which is a mixture of "zinc salts, conductive salts and boron compounds." Of the latter he prefers borax. One of his processes is as follows: About 17 kg of pure zinc sulphate are dissolved in water and one-half of the solution is introduced into a warm solution of about 9 kg of borax. The precipitate thereby formed is dissolved in concentrated sulphuric acid and stirred until congo paper turns only perceptibly blue when wetted by the solution. The other half of zinc sulphate is then added; 170 liters of water is said to be the most suitable proportion for the given weights of salts.

A patent granted to Mr. H. Blackman, of New York City, refers to mechanical details for the construction of electrodes for electrolytic cells and the method of connecting them with the bus-bars, and one granted to Mr. Frank W. Cann, of Brooklyn, relates to mechanical details of an anode hook for electroplating purposes.

BATTERY INVENTION.

Mr. H. B. Ford, of New York City, patents the construction of a zinc amalgam electrode to be used in secondary batteries. He fills a thin porous wooden cup partly with mercury and places into it a thin copper plate plated with zinc and corrugated in a vertical direction. For the other electrode he uses a copper plate covered with peroxide of manganese. As electrolyte is used dilute sulphuric acid of 25° Baume. "The charging current causes the mercury to act upon the zinc and copper plates in the usual way and also forms by the absorption of hydrogen a mercury sponge containing also some zinc, which expands upwardly until (if the preparations be correct) the porous cup is practically filled. In the discharge of the battery there is double action of the oxygen upon the zinc and upon the absorbed hydrogen, respectively. The action upon the hydrogen is first completed, resulting in the disappearance of the sponge. So long as the latter remains the voltage is about 2.5. Upon its disappearance the e.m.f. drops to about 1.5 volts."

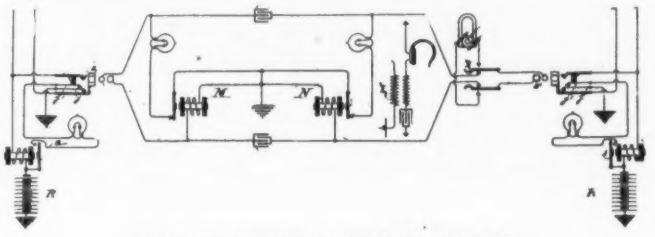
A patent granted to Mr. G. K. Hartung, of New York City, relates to an accumulator plate which consists essentially of a series of porous earthenware cups containing the material to become active, usually an oxide of lead mixed with resilient subdivided inactive material, like finely-divided cork or pure rubber, in order to obviate the difficulty due to the expansion of the active material. Embedded in the active material is a bare conductor. The tubes which form a plate are supported in a frame of insulating strips.

New Telephone Patents.

CENTRAL ENERGY SYSTEM FOR SMALL EXCHANGES.

An extremely simple arrangement of switchboard circuits for central energy working has just been brought out by Mr. W. W. Dean, of Chicago. This new system, which is designed primarily for use in small switchboards, is shown in diagram in the accompanying illustration. At either side of the figure a subscriber's line is shown, while in the middle appears a pair of connecting cords. All relays serve the double purpose of relay and retardation coil; providing not only control of the necessary signals, but also the path of current to supply the subscriber's transmitters.

As may be seen, the grounded battery, *R*, is wired through the line lamp controlling relay, of high inductance, to the subscriber's line wire *a'*, while line *a* in its normal condition connects to ground or to the grounded pole of the battery to a "normal" jack contact *j'*. The illumination of the line lamp in response to the closing of the line circuit by the switch hook is evident, as is also the cutting off of the lamp by the insertion of a plug in the jack in a manner to separate normals *j* and *j'*. The insertion of a plug has another function at the jack, namely, the clearing of the ground normal *j* from sleeve *s*. This transfers the ground return of battery *R* to the cord circuit



DEAN TELEPHONE EXCHANGE SYSTEM.

ground, which can only be reached through the highly inductive relay *M*. This latter relay responding opens the supervisory lamp circuit. The completion of the talking circuits is, of course, through the condensers *l* and *l'*, which serve to separate the circuits of the answering and calling subscribers. As soon as the flow of current to either subscriber ceases following the return of the receiver to the hook, the corresponding relay *M* or *N* de-energized permits the closing of the corresponding supervisory lamp circuit through the jack and plug, and the cord circuit ground. The extinction of this lamp of course occurs with the removal of the plug. A patent for this system has been granted to Mr. Dean and assigned by him to the Kellogg Switchboard and Supply Company.

SELF-RESPONDING TELEPHONE.

Messrs. T. D. and C. J. Freese, of Elyria, O., are the joint patentees of a most novel telephonic device, namely, a self-responding telephone. This is a combination of telephone and phonograph apparatus such that one quitting his office may leave word as to his whereabouts or directions as to a message, for the benefit of any chance telephone caller. In case he desires a message to be left for him by the caller, the first or responding phonograph, after delivering its intelligence, stops of itself and sets in motion a receiving phonograph to record the incoming message. It is hard to say offhand as to just what ends such a combination will lead, but if the responding phonograph provokes the same feelings in the calling party as do the phonographs used in some cities to report busy, the message delivered by the receiving phonograph will be apt to be so rich with choice expletives as to be unfit for publication.

A GERMAN IDEA.

The American is supposed to lead the world in labor-saving devices, but a German named Ritter, residing in Stuttgart, has produced a telephone cord circuit with which the manual labor of the operator is reduced to a mere handling of plugs. With this system the insertion of the answering plug connects the operator to the calling party and restores the line drop. The insertion of the calling plug

then carries on the operations by disconnecting the operator, ringing up the desired station and cutting the clearing out drop into circuit. After a ring-off, the removal of the plug restores the clearing out drop. Now all this would be valuable except that it prohibits the use of all judgment and intelligence by the operator and the use of these by the operator is the chief reason that the manual board holds out successfully against the automatic. A further invention by Mr. Ritter is a toll registering system. As, however, its chief novelty lies in its adaptation to the above mentioned cord system, it does not seem necessary to consider it in detail.

No Municipal Plant for Cleveland, O.

The proposition to bond the city of Cleveland to the extent of $400,000 for the purpose of establishing a municipal electric lighting plant was defeated at the general election on November 3. The vote was 30,501 against the proposition to 24,328 for it. The proposition not only failed to secure the necessary two-thirds of the votes cast upon it, but was lost even by a majority vote, there being 6,173 more votes polled against it than for it. The total vote cast was 67 per cent. of all the voters voting at the general election, which shows that an unusual interest was taken in the matter by the voters generally.

As our readers may remember, the proposition of Mayor Johnson was that this should be a plant not only for the purpose of supplying lights to the streets and public buildings, but it should be a plant to do commercial lighting in competition with the existing companies.

The voters of the city of Cleveland are to be congratulated on the outcome of this proposition, for had they endorsed the measure and entered upon it, it would have been a very costly experiment, for it was well understood that this proposed issue of $400,000 of bonds was to be but the beginning of an expenditure of several millions of dollars, as such an amount would have been necessary to carry out the plans of the politicians who inaugurated the movement.

CURRENT NEWS AND NOTES.

AIDING SCIENTIFIC EDUCATION.—The London *Times* says that a gentleman who wishes to remain anonymous has given, through Prof. Starling, £50,000 to University College, London, to be used for the promotion of higher scientific education and research.

ELECTRIFYING THE ETERNAL CITY.—The Italian Minister of the Interior has approved the project, long mooted, of making Rome a seaport by means of a canal to be twenty kilometers long and to cost sixty million lires. The port is to be formed near the Basilica of St. Paul and will be a thousand meters long and six hundred wide. It will be below the present level of the Tiber, the waters of which will fall six meters, thus providing electric power for light and an electric railway alongside the canal from Rome to the sea. Rome is now receiving electric power from the Falls of Tivoli, twenty miles away, across the Campagna.

DECEMBER A. I. E. E. MEETING.—A regular monthly meeting of the American Institute of Electrical Engineers will be held at the Chapter Room, Carnegie Hall, 154 West Fifty-seventh Street, New York, at 8.15 P.M., Friday, Dec. 18. The following papers will be presented: Automatic Apparatus for Regulating Generator and Feeder Potential, by E. J. Bechtel; Safeguards and Regulations in the Operation of Overhead Distributing Systems, by W. C. L. Eglin; Overhead High-Tension Distributing Systems in Suburban Districts, by George H. Lukes; Gas Engines, by J. R. Bibbins.

BIDS IN ENGLAND.—A cable dispatch from London of December 5 says: "The Corporation of Swansea has accepted a British tender for the extension of the tramway system involving an expense of £103,000, although a German company offered to do the work for £2,000 less. Much attention has been called to this matter, and the question is raised as to whether it is because of Mr. Chamberlain's agitation in favor of preferential treatment of the empire as against foreign countries. Preferences of this kind are becoming far more common than heretofore."

TROLLEY FOR CANADA.—United States Consul Neal McMillan, of Port Sarnia, Ontario, under date of October 7, 1903, says: "This country is not traversed by electric roads (trolleys) to the same extent as is the United States. An excellent opportunity, in my opinion, presents itself for some company to build a road from Port Sarnia to Beaches, on Lake Huron; from Beaches to Petrolia, an inland town of some 10,000 inhabitants; and thence back to Port Sarnia, passing through several villages and the best farming country in Canada. No grading is necessary and there are no streams to bridge. Such a line would be a paying investment."

HOW TO TREAT AUTOMOBILISTS.—In this country, automobilists are lumped together, in a general denunciation, by many communities and journals, and the art has a struggle to secure the support of the leaders of public opinion. In France, it is otherwise. At the automobile show in Paris, President Loubet is presenting a magnificent Sevres vase, to be known as the prize of honor, and called the "Prize of the President of the Republic." At the same time, the Municipal Council of Paris has voted a gold medal, for competitors, to be known as the "Prize of the City of Paris." Let us try to fancy President Roosevelt and the city of New York doing such things.

LETTERS TO THE EDITORS.

The Trolley in New York City.

To the Editors of Electrical World and Engineer:

SIRS:—The writer has read with interest your editorial in the issue of December 5, entitled "Street Railway Conduit Limitations," and noted with some surprise that after your uniformly consistent advocacy of the underground conduit for urban electric street railway work almost from the very beginning of the electric railway industry, you should at length feel under the necessity of favoring an overhead trolley system for the proposed West Street line, in this city, of all others.

Surely, such a confession of weakness and the advocacy of so backward a step as this in electric railway practice at this late day does not speak very well for the resourcefulness and ingenuity of American electric railway engineers, and as one of their number and especially as one of the inventors and pioneer advocates of the underground conduit electric railway system, the writer cannot help but enter his protest against the conclusions reached by you, doubtless somewhat prematurely, as to the impracticability of operating an underground trolley line on such thoroughfares as West Street, where the channel rails, or conductors, are liable to occasional flooding through drainage connections in case of heavy rains or extraordinarily high tides.

In this connection the writer takes the liberty of enclosing you herewith, for publication in your valued journal, a copy of a communication addressed by him on November 28, 1903, upon this subject, to Dock Commissioner Hawkes, of this city, in which a method or methods devised by the writer many years ago in anticipation of the very limitations you speak of, are set forth. These methods, the writer believes, will entirely overcome the objections cited against the underground trolley in the application of the New York City Street Railway Company for overhead trolley privileges along West Street. They will not only permit of the successful operation of an underground conduit on this important thoroughfare, notwithstanding the peculiar adverse conditions complained of, but will, if adopted, bring about certain other improvements in the general electric railway service that have long been needed in this and other cities.

NEW YORK CITY. ELIAS E. RIES.

[Mr. Ries, in his letter to Mr. Hawkes, proposes the use of his system patented several years ago, and now virtually free to the public, of associating with a conduit system a light battery on each car, to be automatically charged while the car runs over the live conduit sections of the road.—EDS. E. W. & E.]

Automatic Telephone Switchboard.

To the Editors of Electrical World and Engineer:

SIRS:—I have read the description of my automatic telephone switchboard appearing on page 925 of your issue, dated December 5, and am gratified at the kind consideration given my humble efforts.

Regarding the criticism that successive jack plates falling upon

each other would be thermally insulated, it is not necessary that this connecting device shall rest directly upon the heated plate; if a series are superposed the rising heated air will produce the disconnection.

As to the criticism that the number of jack plates is liable to run out, one hundred plates can be arranged on a single vertical rod and a series of these rods, each loaded with connectors and arranged like the rods of a squirrel cage, can be rotated into line, one after the other, automatically.

The apparatus is well adapted for use in a large apartment house or in an office building where one circuit is employed between the central telephone station and the apartment building or a suite of offices. The central station operator can place any calling circuit in connection with the called-for exchange circuit, and then, without loss of time, insert one of the perforated cards in an automatic transmitter, and thus complete the connection to the exact individual or sub-station desired; that is, to any occupant of an apartment or to any particular clerk or member of the force in an office. Conversely, the various substations may automatically connect themselves with the telephone central station. The apparatus is, however, susceptible of more extensive use.

NEW YORK. W. B. VANSIZE.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Pulsations of the Direct Current of a Synchronous Converter.—CRAMER.—A detailed account of an experimental investigation in which he repeated, under somewhat changed conditions, the experiments of Banti. The latter had supplied a synchronous converter with single-phase alternating current, the direct-current terminals being first connected to a non-inductive resistance and later to a storage battery which thus was charged. In both cases the power in the direct-current circuit measured by means of a wattmeter was found to be smaller than the product of e.m.f. and current determined by hot-wire instruments. In the case of the ohmic resistance this difference amounted to 5 per cent., and in the case of the storage battery to 15 per cent. In the converter used by Banti, the pole shoe and core was divided by a considerable air-gap into two parts, the exciting windings being placed around the two pieces of the pole. This construction aids the pulsation of the field and may, therefore, be expected to increase the above-mentioned difference, since the latter is due to the alternating superposed on the direct current of the converter. The present author, therefore, used a converter with solid poles. In fact, this change improved the conditions, although the effect of the pulsating currents still exists. In this case, when the direct-current energy is absorbed by a non-inductive resistance, the pulsations of the direct current are negligible, but this is no longer the case when a battery is being charged. The direct current shows here pulsations which, at normal load of the converter, caused a difference of 15 per cent. in the readings of polarized and hot wire, or dynamometric measuring instruments. At lighter loads the difference is still greater. The effect of the capacity of the battery is here decisive and causes the current to lead in phase. The frequency of the superposed current is generally a multiple of the frequency of the supply current; in the author's experiments it was double the frequency of the supply current. If the converter is used as a double-current generator, currents taken from the alternating-current side cause again the direct current to become pulsating. All these pulsations depend upon the intensity of the alternating current and its phase difference with the e.m.f. From the experiments it follows that in determining the efficiency of a single-phase converter, hot-wire or dynamometric instruments should not be used, since the efficiency thus obtained is too high. When the author operated the converter by polyphase currents, no pulsations were observed in the direct current. Field, however, has recently found that under certain conditions pulsations may also occur in this case, although they are smaller.—*Elek. Zeit.*, November 19.

Direct-Current Machines.—FYNN.—The first part of an article illustrated by diagrams on the design of direct-current machines, in which the author intends to deal mainly with smaller machines and to discuss the various details of design. He distinguishes four types which he suggests be called the protected, enclosed, gas-tight and open types. The casing of a motor of the "protected type" forms part of the magnetic circuit, and covers, in the poles, the field coils, and the whole of the running portions except the pulley; the end covers, giving free access to the air, allow good ventilation, which may be increased by the use of fans. The casing of the "enclosed type" is exactly similar, but the openings in the end covers are covered with stout copper wire gauze; this allows a certain amount of ventilation, which may be increased by the use of fans. The casing of the "gas-tight type" is again the same, but the end covers being solid, the machine is actually gas-tight. The "open type" is the ordinary dynamo type. The article is to be continued.—Lond. *Elec. Rev.*, November 20.

Diagram of Repulsion Motor.—BLONDEL.—A brief communication on Osnos' recent paper on the diagram of the repulsion motor. The writer has derived a diagram similar to that of Osnos, but does not agree with him in several points, especially concerning torque and speed. In the diagram (ELECTRICAL WORLD AND ENGINEER, November 21, p. 849) the torque is not represented by JB, but by the perpendicular distance of B from AD. The torque becomes zero at point A and the corresponding speed has a theoretically infinite value as in a series motor. The short-circuit current does not correspond to the maximum torque.—*Elek. Zeit.*, November 19.

REFERENCE.

Theory of Single-Phase Motor with Unity Power Factor.—OSNOS.—A communication referring to two recent articles by Latour and himself on the theory of the compensated series motor. He compares the views, expressed in both articles, and considers that several of Latour's suppositions and results are incorrect.—*Elek. Zeit.*, November 19.

LIGHTS AND LIGHTING.

Carbon Filament Incandescent Lamp.—STRAUSS.—The first part of an article in which the author describes tests which he has made with modern commercial carbon filament incandescent lamps. In recent years the expense of manufacture has been diminished. The consumption of current per candle has been improved very slightly. The average life has even decreased in spite of the better vacuum which has been obtained since the introduction of the Malignani method of destroying the last traces of oxygen by means of phosphorous vapors. From his tests he concludes that normal incandescent lamps of present make should not be used for more than 300 or 400 hours, as otherwise the candle-power will decrease below 25 or 20 per cent. of the original candle-power. He refers to a relation, given by Weber and stating that the horizontal intensity of the light is equal to the square of the product of current and e.m.f. multiplied by a constant. He gives some figures for this constant, which he found to decrease with increasing life of the lamp. The article is to be concluded.—*Elek. Neu. Anz.*, November 15.

REFERENCE.

Lamp Fixtures.—An illustrated description of suspension fixtures for drop lights.—*Zeit. f. Beleucht.*, November 10.

POWER.

Water Power, Statistics and Cost.—MILLER.—An abstract of his presidential address before the Liverpool Engineering Society. France uses water power to the extent of 500,000 hp, the United States 1,500,000, and it is estimated that in Norway 263,000 hp could be supplied by the larger rivers south of Trondhjem without regulation, and by regulation the power could probably be quadrupled. According to Janet, the cost of water power development in France varies from $21.40 per hp to $150 per hp, depending on the head to be dealt with, the lowest expenditure being upon a fall of 140 meters in Haute-Savoie, the horse-power in each case being calculated at the turbine

shaft. At Geneva, for the first group of turbines erected, of 840 hp, and for the river works then completed, the capital cost amounted to $300 per effective hp. The groups of turbines subsequently erected cost but $95 per hp, and the complete works will cost but $135 per hp. At the chlorate works at Vallorbe the capital expenditure upon the development of 3,000 hp had amounted to but $19.45 per hp. At Niagara the rates charged to ordinary consumers by the Cataract Power Company vary from 2 cents per unit for 1,000 units per month or less to 0.64 cent per unit for 80,000 to 200,000 units per month. The cost of electrical energy for power purposes from water power stations in France and Switzerland varies from 2.1 cent per unit for small powers to 1.26 cents per unit for large powers.—Lond. *Elec.*, November 20.

Removing Water from Peat.—An article on an experimental demonstration given recently in London of a process for removing water from peat by electricity, which was noticed in the Digest last week. This writer is also very sceptical concerning the prospects of this process. Incidentally, it is mentioned that the importance of the problem is indicated by the fact that there are 2,830,000 acres of peat bog in Ireland, of which area the red bog occupies 1,576,000 acres, and has a depth of 25 ft.—Lond. *Elec. Rev.*, November 13.

Schwerin.—A paper read before the International Congress for Applied Chemistry on the application of the principle of electric endosmosis to the problem of removing water from peat bog. If a cell is divided by a stationary porous diaphragm into two parts, the phenomenon of endosmosis consists in a bodily transfer of liquid from one side of the diaphragm to the other. When, on the other hand, the diaphragm is movable, the liquid will remain at rest, and the diaphragm will move in a direction opposite to that of the liquid in the former case. Peat bog represents such a porous diaphragm. The author performed the following experiment: A perforated metal basket was suspended and connected as the cathode of an electric circuit. Wet peat bog was placed into the basket and the anode was suspended at the top of the peat. As long as the circuit is not closed, the peat does not lose any of its water, since it is held in its pores by capillary action. But when the current is turned on, the water begins to percolate through the wire basket. Not all the water can be removed by this method, nor are data given concerning the cost of the process, which, however, is based on a correct principle.—*Electrochemical Ind.*, December.

REFERENCES.

Steam Turbine.—An illustrated description of a 1,500-kw vertical shaft Curtis steam turbine, with a description of its main features.—Lond. *Elec.*, November 20.

Traction.

Fire-Proof Cars on the Central London Railway.—A description of the make-up of the experimental trains which comprise two motor cars and four trailers, and which have been on trial on the Central London Railway for eighteen months. They have now been adopted as standard, although it is probable that seven-car trains will be run instead of six-car trains, an additional trailer being attached. The most interesting feature of the equipment is the special motorman's compartment, which is a self-contained steel structure placed over the motor trucks to accommodate the electrical equipment. The framework of this compartment is bolted to the framework of the car body, and is fire-proof in every particular. It is essentially a sheet steel structure. A sheet of uralite or asbestos is used to cover the rear partition between the motorman's compartment and the body framing, and the floor of the cab is composed of cast-iron plates, except on the front platform, the plates being hinged to give access to the motors. The master controllers, contactors, reversing switches, resistances and other apparatus are carried on the platform of the motor cars, the contactors being inside the cab and the reversing switch and rheostats arranged below them. The switches and fuses for the main motor circuit, controller circuit, lighting and air compressor circuits are arranged on the slate panel, the motor circuit connections being a bare copper rod, while those of the controller circuits are of asbestos-covered wire.—*St. R'y Jour.*, November 7.

REFERENCES.

High-Tension Direct-current Thury System for Traction.—Soulier.—A full illustrated description of the La Mure electric railway, operated by the Thury system with 2,400 volts between the trolley wires, or 1,200 volts between each trolley wire and the rails, which serve as neutral, as already recently noticed in these pages, and in the Digest.—*L'Industrie Elec.*, November 10.

Dunedin Tramways, New Zealand.—A description of the progress made in the work of installing the electric tramway system at Dunedin, New Zealand. The car house is completed and ten cars have been equipped and are ready for operation. A temporary steam plant has been installed, comprising water tube boilers and three engine-driven generators of 200-kw capacity each. This will be supplanted eventually by a water power plant.—*St. R'y Jour.*, November 7.

Installations, Systems and Appliances.

British Central Station.—Pontifex.—An illustrated description of the Isle of Thanet Electric Tramways & Lighting Company's system. The power house contains two 300-kw, 2,500-volt, three-phase generators, two 200-kw, 500-volt, direct-current generators, and one 100-kw synchronous converter with three transformers. The battery consists of two sets of 265 Tudor cells with a capacity of 280 amp.-hours, if discharged to a minimum voltage of 490, with a maximum discharge rate of 72 amp.; the maximum charge rate is 40 amp. The three-phase currents are transmitted to two synchronous converter substations. The traction system comprises at present 10 miles of double track and 1 mile of single track.—Lond. *Elec. Eng.*, November 20.

REFERENCE.

High-Tension Switches.—The first part of an article illustrated by diagrams, in which a summary is given of the various constructions by German manufacturers of high-tension switches. They are mainly based on the principle that in order to avoid sparking at the main contacts, a secondary contact point is provided in shunt with the main contact. Different forms of the well-known horn type of switch are described in which, when one or the other horn is moved, the arc betwoeen is made to move upwards until it breaks. The present installment deals with circuit-breakers actuated by hand. In a continuation of the article automatic circuit-breakers will be described.—*Elek. Anz.*, November 19.

Electro-Physics and Magnetism.

Capacity of a Vacuum Tube in a Magnetic Field.—Lopuchin and Afanasieff.—An account of experiments in which they studied the variation of capacity undergone by a vacuum tube in a magnetic field. They found that there is a close correspondence between luminosity and capacity. They used Borgmann's method for the determination of very small capacities, and compensated the capacity of the vacuum tube by means of two burettes containing mercury. They used a string interrupter which was kept going at a uniform rate by controlling the note emitted by it. The axis of the tube was placed either parallel or perpendicular to the lines of magnetic force. In the first case, the capacity was perceptibly diminished by exciting the magnetic field, whereas in the second case it was strongly increased. The luminosity changes in a corresponding manner. As long as the tube is not luminous the capacity of the tube is constant. The capacity of the electrodes alone is then brought into play. The capacity of the tube is a maximum at a pressure of 1 mm. At about 0.05 mm. it suddenly falls, and the luminosity disappears at the same time. The magnetic effect is strongest at pressures at which the cathode rays begin to appear. At a pressure of 0.07 mm. the magnetic field simply extinguishes the light, if the position of the tube is axial. With an equatorial field, the maximum magnetic effect occurs at a pressure of 5 mm. At very high vacua, when the tube remains quite dark, the magnetic field always increases the capacity of the tube.—From *Phys. Zeit.*, November 1; Lond. *Elec.*, November 20.

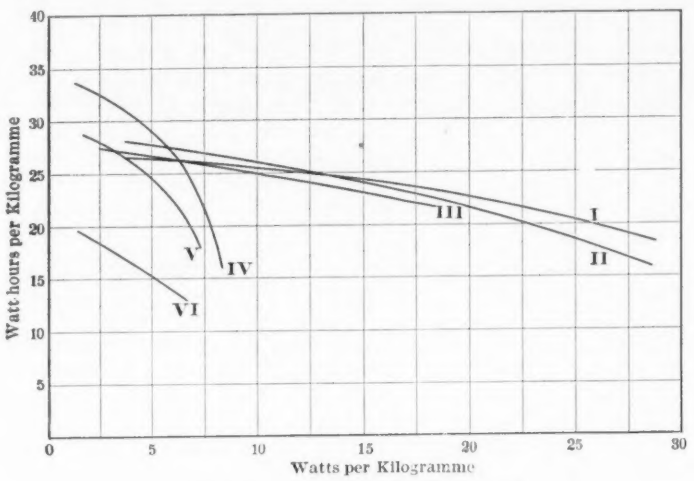
Magnetic Manganese Alloys.—Hensler.—An account of measurements showing that alloys, made from practically non-magnetic metals, may be magnetic. The best results were obtained with a copper alloy containing 26.5 per cent. of manganese and 14.6 per cent. aluminum, i. e., manganese and aluminum in nearly atomic proportions. This alloy showed an induction of several thousand units in fields ranging from 20 to 150 units. A considerable improvement was obtained by keeping it at 110° C. in boiling toluol for two days; the induction was then 4,500 units in a field of 10 units and 5,500 in a field of 150 units. When the percentage of aluminum was reduced to 3.6, the alloy ceased to be magnetic. Similar results, although not so good, were obtained with tin instead of aluminum. Arsenic, antimony, bismuth and boron also yield magnetizable alloys. —From *Verh. Deut. Phys. Ges.*, June 12; Lond. *Elec.*, November 6.

REFERENCE.

Conductivity of Selenium.—VAN AUBEL.—An account of experiments in which he found that besides being subject to variation by light and by Röntgen rays, the conductivity of selenium is also affected by rays emitted by hydrogen peroxide, by essence of turpentine and by certain bodies (like india rubber and camphor) after they have been exposed to the action of ozone.—From *Phys. Zeit.*, November 1; Lond. *Elec.*, November 20.

ELECTRO-CHEMISTRY AND BATTERIES.

Edison Accumulator.—HOSPITALIER.—An account of a series of tests which he has made with the Edison nickel-iron storage battery, simultaneously with other tests made by the Central Laboratory of Electricity in Paris. He made a series of 21 charges and discharges, partly under so severe conditions that a lead cell would have been put out of service, while the Edison cell was not hurt. In the twelfth discharge the cell was discharged nearly short-circuited, but had in the thirteenth discharge, two days later, nearly the same capacity; and the same was the case in the fourteenth discharge, more than three weeks later, the battery having remained at rest in a charged condition during this time. From his tests and those of others he concludes that the Edison battery can be used with charge and discharge rates which would be excessive for the lead cell, while the Edison battery is not hurt, nor does it lose any considerable amount of capacity. From curves, given by the author, it appears that the ampere-hour capacity was about 175, 162, 160, 155 for discharges at 30, 60, 90, 120 amp., respectively. The difference between the mean voltage at the terminals for discharges at 30 and 120 amp. was less than 0.2 volt. The durability of a storage battery is indicated by the total energy given by the battery during its life per kilogram of its weight. The best lead cell, tested in the accumulator tests of the French Automobile Club in 1899 gave 1.5 kw-hour per kg. (Fulmen cell). The tests of the Edison battery have shown that it has a capacity at least twice as great. The disadvantages of the Edison



DISCHARGE CURVES OF EDISON CELLS.

cell are its higher price and the fact that its useful voltage is about 1.1, against 1.9 for the lead cell. This means more cells, more connections, etc. The efficiency of the lead cells in the Automobile Club tests, for the low charge and discharge rates used, was between 70 and 75 per cent. The efficiency of the Edison battery, when charged at 60 amp. and discharged at varying rates, was 50 per cent. The author states, however, that this superiority of the lead cell is only apparent, since a fair comparison would require equal rates of charge and discharge. The adjoining diagram gives some curves which are characteristic for the Edison cell and show its adaptability to automobile purposes, especially the possibility of its use with high discharge rates. The curves give the watt-hours per kilogram as function of the watts per kilogram. IV, V, VI are the curves for lead cells (Contal. Fulmen, Blot-Fulmen, respectively), while I, II, III are curves for the Edison battery, as determined by three different experimenters. The difference in the appearance of the two sets of curves is very pronounced and shows that the Edison battery can be worked at very wide limits of discharge rates, utterly impossible with the lead cell. The volume of the Edison cell per normal watt is smaller than that of the lead cell; the volume per watt-hour, however, is greater. The author concludes that the Edison accumulator represents an important and incontestable advance for electric automobile purposes, and that its advantages assure to it numerous applications.—*L'Industrie Elec.*, November 10.

Electrodeposition of Aluminum from Aqueous Solutions.—McDERMOTT.—A communication in which the author gives a solution for the deposition of aluminum not hitherto used. This is made by dissolving metallic aluminum in a solution of ordinary copper sulphate. A reaction takes place between the aluminum and the monohydrated sulphate, with the result of a precipitation of copper and the formation of a soluble basic aluminalum salt. The solution is ready for use when the precipitation of the copper is complete, the liquid then being clear and the solution tasting strongly of alum. The deposition is of a dull lead color on the surface, but takes the characteristic color of aluminum under the buffer. If the current is too strong or the cathode too small, the deposit will consist of an impalpable lead-colored powder. During the deposition gas is evolved at both plates, from which it must be removed by jarring the plates. On standing unused the solution deposits white aluminum hydroxide and is apparently changed into the normal sulphate, from which as well as from the chloride and acetate, the metal will not deposit except as the hydroxide or as a fine gray powder. An e.m.f. of about two volts is required for the process. A part of the metal may be deposited as a powder and part in the compact form at the same time.—*Am. Elec.*, November.

Copper, Nickel and Zinc from Chloride Solutions.—KOEHLER.—The conclusion of his long and fully-illustrated article on the development of the various electrometallurgical methods for producing copper, nickel and zinc from chloride solutions. This installment deals mainly with the processes of Hoepfner and Browne and with the developments at Hamilton (Frasch process).—*Electrochemical Ind.*, December.

Iron and Steel in the Electric Furnace.—GOLDSCHMIDT.—An illustrated translation of his paper read before the International Congress for Applied Chemistry on electric furnace processes for iron and steel. Very complete information is given on the Stassano process, and some information also on the processes of Keller, Heroult and Kjellin.—Lond. *Elec.*, November 20.

Endosmosis.—BREDIG AND SCHWERIN.—Two papers, read before the International Congress for Applied Chemistry. The paper by Bredig deals with the theory of electric endosmosis and its application to colloidal solutions. The paper by Schwerin deals with the application of endosmosis to removing water from peat bog, an abstract of this paper being found under "Power."—*Electrochemical Ind.*, December.

Theory of Colloidal Solutions.—PERRIN.—An article in which the author puts forward the theory that every colloidal solution is made up of granules, invisible in the microscope, but much more bulky than the molecules, and charged electrically. The author traces the development of these granules from the first conglomeration of atoms.—From *Comptes Rendus*, October 12; Lond. *Elec.*, October 30.

Course in Electrochemistry.—TUCKER.—An illustrated article in which the author gives laboratory notes on exercises in practical electrochemistry, which were prepared for use in the electrical engineering department of Columbia University, to give the students familiarity in the practice of electrochemistry, and particularly in the use of the electric furnace. General instructions are given and partly illustrated by diagrams.—*School of Mines Quart.*, July.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Capacities as Multipliers for Electrostatic Voltmeters.—BENISCHKE.—A communication referring to the recent paper of Marchant & Worrall (Digest, October 24). The principle of using low-reading static voltmeters for high-tension measurements on alternating-current circuits, by connecting two condensers in series across the circuit and connecting the voltmeter in shunt with the larger condenser, has been used for two years by the Allgem. Electr. Ges., of Berlin, which manufactures apparatus for this purpose up to 40,000 volts. With higher voltages, however, not two, but three or four condensers in series, are employed.—Lond. *Elec.*, November 20.

New Books.

A HANDBOOK FOR THE ELECTRICAL LABORATORY AND TESTING ROOM. By J. A. Fleming, D.Sc., F.R.S. Volume II. London: *The Electrician* Printing and Publishing Company, Limited. 622 pages, 188 illustrations. Price, 14 shillings.

This is the second and completing volume of a work, the first

volume of which appeared in 1901. It deals with the measurement and tests of electric quantity, energy, capacity, induction, photometry, magnets and iron, dynamos, motors and transformers. These subjects are considered in five chapters.

The book is excellently adapted for text-book service, and for a volume of reference in electrical laboratories. It is also modern and up-to-date. The descriptions are distinct and the type is clear. The mathematical treatment is also excellent, the author's ability in this direction being well known. The notation and symbols employed appear to be mainly in conformity with the international system, for which much praise is due. Thus, current strengths appear under the symbol I, which is international, although occasionally they appear under A, which is uncanonical.

An unfortunate definition appears in the chapter on magnetic testing. Here the C.G.S. unit of magnetic flux is named a "line," although the nearly universal international usage calls it a "maxwell," following the resolutions of the Paris International Electrical Congress of 1900. Moreover, 10^8 C.G.S. units of magnetic flux are named one "weber," which is an unfortunate name, and an unfortunate magnitude, naturally leading to the use of the earth quadrant as the unit of length in magnetic equations.

There is a good bibliographical list at the end of each chapter. The book deserves to be found in every electrical laboratory, and to be studied by all students of electrical testing.

CALENDAR OF INVENTION AND DISCOVERY. By John Cassan Wait. New York: McGraw Publishing Company. Cloth, illustrated. Price, $1.00; Wall Calendar, price, 60 cents.

This is a remarkable little book, if book it can be called, although that word seems as much a misnomer as calendar. It is in reality an encyclopedic epitome of scientific biography, and the scope and range of it can perhaps be best explained by taking some one individual day or topic. This again is difficult, as, for example, taking the subject of telegraph, we find it referred to under no fewer than 30 different dates. Taking the page devoted to April 27, we find it devoted in part to Prof. Morse, who was born on that day, 1791. There is a brief biographical sketch and the date of his death. There is also a poetical quotation from Lowell on the telegraph, and other pithy little citations of verse. This is a very neat little treatment of the subject. On the same page, however, appears Andronicus, the Grecian architect. This again has a citation from Lowell and a number of references to architectural achievements. There is no particular reason why Andronicus should be assigned to this day, but the material fills out the page interestingly. Five minutes each morning can be spent to advantage running one's eye over such text. Under February 11 we have a neat little biographical sketch of Edison, who was born on that day, 1847, and of William Kelly, the iron and steel inventor, who died February 11, 1888. There are two poetical quotations accompanying these biographies and on the opposite page are two illustrations, one of which shows Edison in his laboratory contrasted with a philosopher in his laboratory of the old school.

As a general thing, the page opposite, or back of the calendar page, is left blank for notes, and the type is printed vertically, up and down, the page in two columns, instead of across, horizontally. The matter thus presented for hundreds of individuals and hundreds of inventors is in remarkably compact shape and evinces an incredible amount of intelligent research and application. Moreover, it is easy to find any particular reference as there are four separate indices; one of illustrations, one of poetical quotations, one of persons, and one of topics or inventions. This little book, therefore, is not only a very excellent thing to have in one's own possession, but a timely and appropriate gift at this season of the year for anyone devoted to scientific or mechanical pursuits. We doubt if Mr. Wait can ever recoup himself for the time and thought expended on it; but it should enjoy a large circulation, either in the book form or in the wall calendar form, the price of which is equally reasonable.

New York Electrical Trades Society Annual Meeting.

The annual meeting of the New York Electrical Trades Society was held at the Arena, New York City, on the evening of December 8, when there was a large attendance. This useful body is continuing to do excellent service in a quiet and unobtrusive manner, and the reports of the secretary and treasurer both showed the Society to be in a flourishing condition, with steady accessions in membership. Mr. Frederick Vose, secretary of the National Credit Association of the industry, was present from Chicago and addressed the meeting in regard to the advantages secured by the Society's work, and the proposed new branches to which effort might be directed. The following directors were then elected for the ensuing year: Messrs. Reed, Bennis, Schwartz, Gorman, Marshall, Dale, and Gallaher. Owing to the lateness of the hour, the election of officers did not take place, but it is understood the present list will be re-elected. Mr. R. E. Gallaher was again chosen, for the seventh or eighth time, as delegate of the Society to the National Electrical Credit Convention, at which all the cities or centers are represented.

After the regular business an admirable dinner was served by Muschenheim, at which not less than 50 or 60 sat down. The table was dressed with flowers and illuminated prettily with incandescent lamps, and the arrangements reflected great credit on Messrs. Gallaher and Dale, who organized the affair. President H. A. Reed took the chair and after dinner opened with some pertinent remarks. Mr. Wheeler, representing the credit clearing house, of Chicago, presented the plan of a most intresting scheme for imparting information to members regarding credits. He was heard with deep attention. Mr. E. Ward Wilkins, of Philadelphia, made a felicitous and amusing speech, and timely remarks were also made by Messrs. F. Vose, T. C. Martin and R. E. Gallaher. Altogether a most enjoyable and profitable meeting was had, and the first dinner was such a success it is certain the event will become an annual fixture. Secretary Eckert and the other officers received many congratulations.

Telephone Convention Exhibits.

By Special Telegram.

The exhibits at the Independent Telephone Convention in Chicago, December 8, 9 and 10, were under the direction of Mr. C. E. Tripp, of the Auditorium Hotel. The following concerns exhibited apparatus, etc.:

THE AMERICAN STONE CONDUIT COMPANY was represented by G. Painter and W. W. Smythe.

FRANK B. COOK TELEPHONE ACCESSORIES were represented by B. B. Cook, J. Cook, R. Roy Cook, F. A. Parker and C. E. White.

CHICAGO NUT COMPANY was represented by C. F. Hessinger.

KELLOGG SWITCHBOARD & SUPPLY COMPANY was represented by W. W. Dean, chief engineer; A. E. Barker, sales manager; F. J. Dommerque, special representative; P. W. Bossert, St. Louis representative; H. N. Ferris, R. H. Manson, W. J. Gunn, G. L. Ainsworth, W. R. Hines, G. H. Lutz, C. B. Forest, H. E. Krause, R. S. Mueller, A. B. Kratz.

THE AUTOMATIC ELECTRIC COMPANY was represented by H. D. Critchfield, J. F. Crook, H. S. Durant, F. Lucia, H. D. Ogden and W. E. Cook. The exhibit was unusually interesting, as showing the automatic telephone outfit connected with the Chicago automatic exchange, and also part of the 10,000 exchange in operation.

THE VALENTINE CLARK COMPANY was represented by E. L. Clark, F. L. McGillan, and showed photographs of pole yards.

THE MILLER ANCHOR COMPANY was represented by President G. H. Miller and F. B. Miller, vice-president, with a line of Miller anchors for poles and augers.

THE ALLEN HUSSEY COMPANY interior telephone system was represented by President C. J. Huff and Secretary-Treasurer J. F. Boland.

THE NICHOLAS SELECTOR COMPANY, of Rochester, N. Y., represented by C. E. Nicholas, exhibited its party line selective device for rural service.

THE WESTERN TELEPHONE MANUFACTURING COMPANY was represented by Mr. J. E. Keelyn, manager; Mr. W. G. Peacock, engineer; and Mr. E. Schwartz. The company distributed small jacks and cord on pins as souvenirs.

THE INDIANA STEEL & WIRE COMPANY was represented by R. Miller, the secretary and sales agent, and E. F. Kitselman, general manager.

WARNER ELECTRIC COMPANY, Muncie, Ind., was represented by Mr. F. W. Warner, in behalf of his pole changer.

THE CHICAGO TELEPHONE SUPPLY COMPANY, of Elkhart, Ind., was represented by Messrs. G. A. Briggs and B. L. McCoy.

THE GENERAL ENGINEERING COMPANY, E. W. Hammer, president, and H. J. Minhinnick, secretary, showed photographs and plans of plants constructed.

NEW HAVEN NOVELTY COMPANY, H. Grant Thompson, treasurer, and Charles Luke, manager, made an exhibit of its brass splicing sleeves, potheads, etc.

CHICAGO WRITING MACHINE COMPANY, R. E. Hill, general manager, and F. W. Pardee, corresponding secretary, had an exhibit of the adjustaphone.

ROBERT WATSON, of Menominee, Mich., was represented by M. E. Brown and A. D. Watson, who had a miniature representation of a pole yard.

MONARCH TELEPHONE MANUFACTURING COMPANY was represented by W. H. Trimm, sales manager, and J. C. Hubacher, secretary, as well as C. E. Yaxley, general manager. The exhibit included some interesting special features, such as transmitters working in water. One of the instruments had gone through fire at Webster City, and one through flood at East St. Louis.

NATIONAL WIRE COMPANY, of New Haven, Conn., was represented by Mr. R. B. Abbott, Chicago sales agent, who made demonstrations with the wire meeting Western Union standard requirements.

CROUSE-HINDS COMPANY, of Syracuse, N. Y., were represented by Mr. F. F. Skeel, Western manager, who showed a new guy anchor and method of installation.

MOON MANUFACTURING COMPANY were represented by Mr. H. E. Procunier, manager.

MR. F. H. WOOD showed a line of terminal leads.

CHICAGO DIE AND ELECTRICAL COMPANY was represented by Mr. M. L. Bowker, with a line of electrical fuses.

VESTA STORAGE BATTERY COMPANY was represented by Mr. D. P. Perry, vice-president.

EUREKA ELECTRIC COMPANY was fitly represented by President I. J. Kusel and Messrs. H. K. Kusel and H. Rosenow.

MCROY CONDUITS were, as usual, spoken for by E. F. Kirkpatrick.

ELLIOTT ADDRESSING MACHINE COMPANY was represented by Mr. R. St. John.

SIGNALPHONE COMPANY, of Milwaukee, was represented by Superintendent E. E. Salisbury and R. R. Rogers, salesman.

H. B. CAMP COMPANY was represented by Mr. J. A. Hammett, sales agent.

GORDON BATTERY COMPANY, of New York, was represented by Mr. E. M. Deems, Western agent.

WILLIAMS-ABBOTT ELECTRIC COMPANY, of Cleveland, was represented by President L. Sands and J. A. Wright.

W. J. BARR MANUFACTURING COMPANY, of Cleveland, was represented by President W. J. Barr and L. J. Lebornew, in the transmitter arms.

FULMER, KUESTER, SCHROEDER COMPANY was represented by D. M. Fulmer, J. W. Fulmer and H. C. Miller, who had small cedar poles with cross arms placed in the halls and in the room.

CENTRAL TELEPHONE & ELECTRIC COMPANY was represented by J. S. Cumming, president; C. H. Wallace, vice-president; W. F. Gradolph, engineer.

W. H. ANDERSON & SONS were represented by W. R. Anderson and T. H. Tapp.

STROUND TELEPHONE SPECIALTY COMPANY was represented by H. D. Stround.

NORTH ELECTRIC COMPANY, of Cleveland, had an exhibit, including photographs of work installed. It was represented by C. H. North, president; R. Hendrickson, G. B. Pratt and F. F. Saff.

STANDARD UNDERGROUND CABLE COMPANY was represented by J. R. Wiley.

STERLING ELECTRIC COMPANY, Lafayette, Ind., gave away miniature telephones as souvenirs. It was represented by W. E. Doolittle, president; H. A. Taylor, vice-president and secretary; S. B. Fowler, electrical engineer; H. S. Bullock, superintendent; H. T. Doolittle, purchasing agent; Evan Shelby, sales manager; K. V. Murry, traveling representative; G. W. Metcalfe.

F. BISSELL COMPANY, of Toledo, O., was represented by W. S. Bissell, M. S. Walker and E. B. Terry.

ILLINOIS ELECTRIC COMPANY was represented by M. McNeill, Jr., and C. J. Litscher, who distributed souvenirs of a healing nature.

KESTER ELECTRIC MANUFACTURING COMPANY was represented by A. J. Witherell, president; F. G. Dickerson, manager, and J. E. Goodman.

NAGEL COLLINS MANUFACTURING COMPANY exhibited a line of enclosed fuses.

AMONG the companies present not making an exhibit were the Western Lumber & Pole Company, of Denver, B. F. Vreeland, president; the Maltby Lumber Company, handlers of Michigan white cedar poles, etc., represented by E. E. Reynolds; Lindsley Bros.' Company, represented by E. A. Lindsley and J. A. Navarre; Elmore, Fowler, Jacobs Company, J. H. Fowler president, E. Elmore, secretary; National Carbon Company, M. B. Moffett and F. W. Ward; F. B. Badt Company, F. B. Badt and G. M. Willis; Gould Storage Battery Company, E. L. Draffen; C. L. Peirce, Jr.; C. J. Huebel Company, Menominee, Mich., poles; Crawfordsville Wire Nail Company.

English Report on the Edison Storage Battery.

Some months ago we printed an abstract of the report from Mr. W. Hibbert, an English engineer, on the Edison storage battery, and we give below the principal points of a further report made by Mr. Hibbert

The standard automobile cell is of rectangular shape. It stands 13 in. high (over all) and measures 5.1 by 3.5 in. horizontally, the weight being 17.8 pounds. It contains 14 positive and 14 negative plates. Each plate is made of sheet steel, nickel-plated, punched with 18 rectangular holes. In each of these holes is inserted a flat pouch or pocket containing the active material. The walls of these pockets are perforated by exceedingly fine short slots, through which the liquid can penetrate. Thus the current can easily pass to and from the active material contained in the pocket.

Both positive and negative plates are alike, except in respect to the active materials. The pockets on the negative plate contain finely-divided iron, those on the positive contain peroxide of nickel.

The liquid is a 20-per-cent. solution of potash. This suffers no change during the action of the cell, except the loss of a small quantity of water, which is decomposed while the cell is being charged.

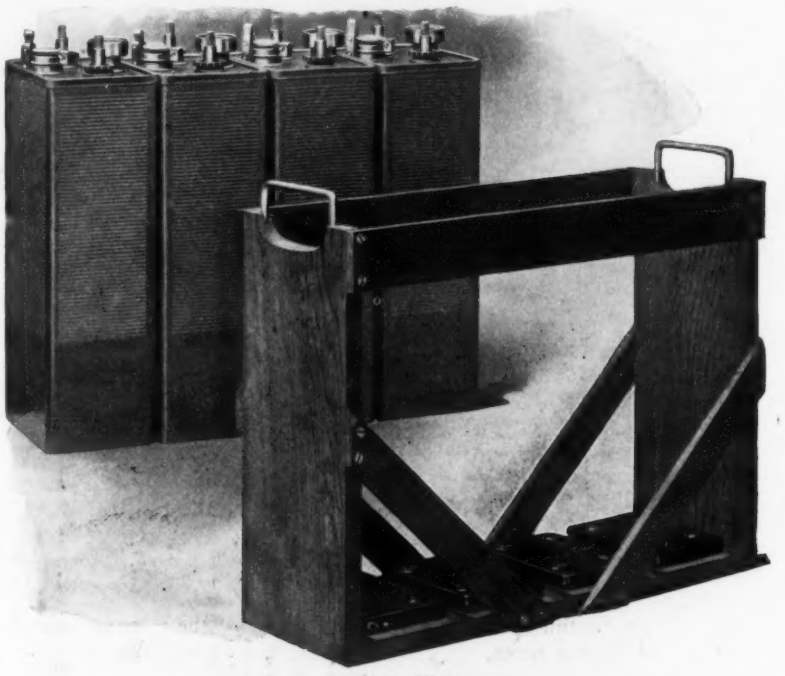


FIG. I.—FOUR CELLS AND TRAY.

As an immediate consequence, a small quantity of liquid suffices. It is wanted simply to play the part of an electrolytic conductor, and in no way to provide active material in the ordinary sense. The plates may, therefore, be fixed very near each other, for the narrow intervening space allows a perfectly adequate supply of potash solution.

The proximity of the plates does not apparently involve danger of short-circuiting. The plates are thin, but being made of steel, their rigidity is exceptionally good. Mechanical stability is further assured by vulcanized rubber separators, the whole forming a compact mass calculated to resist all the ordinary mechanical shocks it is likely to undergo. Mr. Hibbert says that the only special mechanical difficulty which occurred to him was the chance that the gases evolved during a charge might eject some of the active material from the pockets. He therefore watched the pockets carefully, especially during very heavy charges, but without finding any evidence of loss.

The cell is sealed in its steel case. Two stout connecting pins (from the positive and negative plates, respectively) come through

liquid-tight bushes of vulcanized rubber. These pins are made slightly conical, as are also the connectors which fit on them, and the mechanical finish and easy grip of this terminal add to the value of the battery. A further advantage lies in the fact that these connecting pins have a much higher specific conductivity than those of the ordinary type of accumulators.

On the top of the case (Fig. 5) there are also (*a*) a spring stopper, with rubber flange, covering a hole by which the electrolyte is introduced, or distilled water added from time to time; (*b*) a vent hole guarded by a gravity valve. This provides for the escape of the gas evolved during charge. The hole and valve are covered by a gauze nipple, which prevents escape of spray while allowing gas to pass.

The e.m.f. is 1.33 volt, and the internal resistance 0.0013 ohm. The output at 60 amp. is 210 watt-hours, or at the rate of 11.8 watt-hours per pound of cell. When the cell is examined as to discharging values its excellence becomes most pronounced. At high rates of discharge rising to many times the normal, it suffers no appreciable polarization, and therefore recovers its normal voltage almost instantaneously when the current returns to an ordinary value.

Discharge rate in amperes.	Time of discharge.	Output in ampere hours.	Per cent of the 30 ampere output.
30	5 hrs. 46 min.	173	100
60	2 hrs. 51 min.	171	99
90	1 hr. 51 min.	167	96.5
120	1 hr. 21 min	162	93.6
150	1 hr. 2 min.	154.5	89
200	42 minutes	142	82

The above table exhibits the actual and relative output of the Edison cell at varying discharge rates.

It is stated in the report that while some approach has been made to the above output of 11.8 watt-hours per pound of cell by special lead cells, the design has involved a very early fall of capacity and a rapid deterioration. If the specific output of the Edison cell is

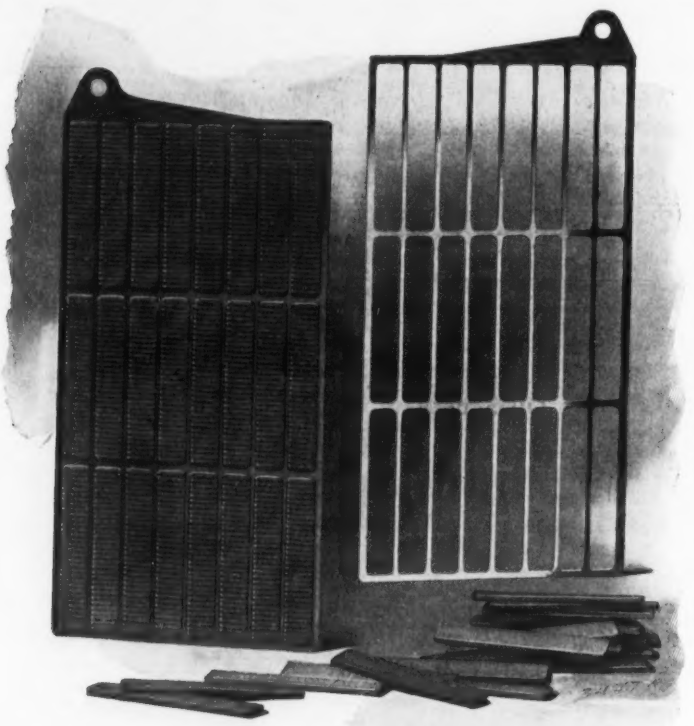


FIG. 2.—FINISHED PLATE, GRID AND POCKETS.

compared with that of the better class of lead cells made for traction purposes, it will be found that it is from 25 to 50 per cent. greater. Moreover, the output of the cell does not change during a run on ordinary roads amounting to 1,700 or 1,800 miles, while if the comparison were made after the two types of cells had been run over 1,000 or 1,500 miles, the superiority of the Edison cell would be very pronounced.

In some tests made by Mr. Hibbert the temperature arose to something like 53° C., partly by reason of high external temperature and partly because of the heavy current passing through the cell. It was found that the cells were not at all the worse for being exposed to such a high temperature. One of the smaller cells was short-circuited for 48 hours and after a subsequent lengthy charge it gave a discharge of somewhat less than normal, and after a second charge it

FIG. 3.—TWO PARTS OF POCKET WITH LOOSE ACTIVE MATERIAL, ALSO LOADED POCKET.

had fully recovered. In order to ascertain the readiness with which the cell recovered from an excessive transient discharge (such as often occurs in traction work), discharges were alternated from 60 to 230 amp., a careful watch kept on the voltmeter to see how the cell responded to the variation in current. Recovery was practically instantaneous, the voltmeter coming back to its upper reading almost immediately.

Tests were made at high discharge rates as follows: After charging for one hour at 177 amp., the cell in discharging gave 124 amp.-

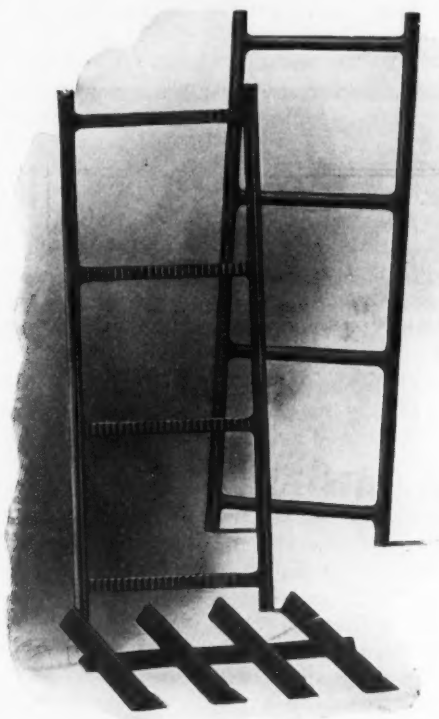


FIG. 4.—HARD RUBBER PLATE-SEPARATORS AND CELL INSULATING PLATE.

hours, or 70 per cent., of the charge; when charged at the rate of 150 amp. an hour, it gave 107 amp.-hours on discharge, or 71 per cent. of the discharge; and when charged at the rate of 205 amp. for one hour, on discharge it gave 142 amp.-hours, or 70 per cent. of the discharge. Experiments on excessive rates of discharge indicated that when the potential difference reaches the value .9 volt, it falls very rapidly with currents of ordinary value. If the discharge be kept up, the fall is arrested when the voltage reaches the value of about .5 volt, and the current flows steadily for some time at this

lower pressure. So far as Mr. Hibbert has been able to detect, there have been no injurious effects as a result of such low discharges; but here, as in the case of the short-circuited cell, there is need for subsequent excessive charging.

Experiments were made on the Edison cell both in a charged and discharged condition. The cell was discharged at 60 amp. immediately after charging, and gave 170 amp.-hours. It was again discharged with two days intervening between charging and discharging, the result being 150 amp.-hours, or 90 per cent. of the full discharge; part of the 90 per cent. deficiency was attributed to loss of current in the gases filling the pocket at the end of a discharging operation. The cell was again charged and put aside for 26 days when it yielded 124 amp.-hours. As to efficiency, at 30 amp., the watt-hour efficiency is about 66 per cent.; at 60 amp. it is about 60 per cent. and charged at 100 amp. and discharged at 60 the efficiency fell to about 50 per cent. Charged at the higher rate of 177 amp.

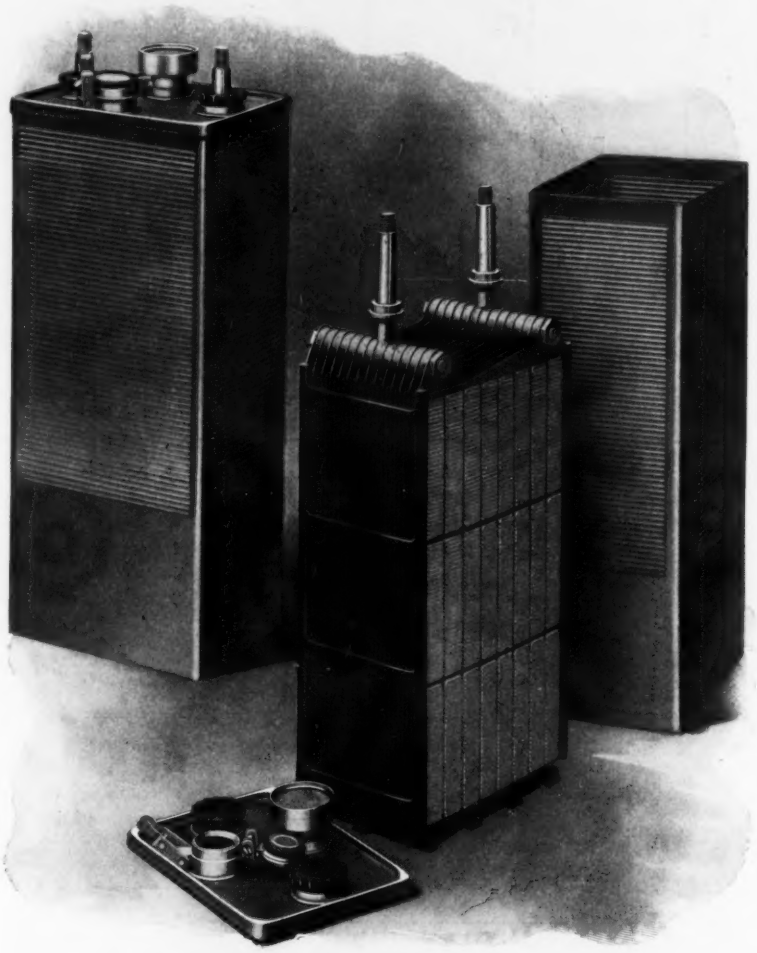


FIG. 5.—COMPLETE CELL, CAN, PLATES ASSEMBLED AND COVER.

and discharged at 60 amp., the efficiency was almost exactly 50 per cent.

The report gives an account of a lengthy trip in an automobile equipped with Edison cells. The total weight of the automobile with two people was 950 pounds and the 38 cells of the battery with their case weighed 700 pounds exactly. When the automobile was turned over to Mr. Hibbert it had already been driven about 400 miles with the battery. The run, which was made partly in France and partly in England, extended from August 29 to September 29, the total distance being 507 miles, and the daily runs varying from 29 to 77½ miles.

Before starting on the journey the battery was discharged and yielded 159 amp.-hours, and observations of the ammeter during the various runs led to the conclusion that about 150 amp.-hours were delivered per charge. In one run, however, under very trying conditions as to weather and road, it was estimated that the output was at least 190 amp.-hours, in this case the latter part of the trip being made with very low battery voltage. The battery was recharged without difficulty the next day and no effect was noticed from the hard usage which it had received. On one of the days the battery ran down until the voltmeter showed .75 volt per cell, and was then charged for one hour at 150 amp.; the subsequent discharges on the road gave 107 amp.-hours, which is 71 per cent. of the charge, the distance run having been 32 miles. Another case of one hour's charge of 186 amp.-hours was followed by a run of 31 miles and a discharge of 134 amp.-hours.

The experiments at one time were interrupted and the automobile put aside for ten days with the battery discharged; at the end of that time it was charged 44 minutes at about 200 amp. and 16 minutes at about 120 amp., making a total of 180 amp.-hours in one hour. The automobile then covered 31 miles, yielding 134 amp.-hours, or giving an efficiency of 72 per cent., the same figure that had been obtained in laboratory tests. During the work on the road, the capacity of the battery did not change. At Paris this was 159 amp.-hours, and at the end of the month the capacity was found to be 158 amp.-hours.

The report gives some instructions as to the care of the Edison battery. The cell should be refilled with water every five or six charges, and more frequent filling will be necessary if there is much overcharging. One important point brought out on the runs above referred to, was the excellence of the cell terminals. From the beginning to the end of the 500 miles of run not a single terminal was touched, and the terminals and connectors were not affected even when carrying a current of 200 amp. As to frothing, in three or four months of continuous working with Edison cells, frothing was only observed in one cell, and that only on two occasions, lasting less than one minute on each occasion. While on the road with the battery one or two cells out of the 38 frothed for a little while after being filled too full, but only for a few minutes. In several cases it has been found that where cells have been "touched up" with a bit of oily waste they froth; and oil and grease should be avoided even

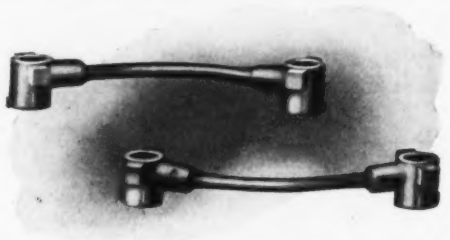


FIG. 6.—CELL CONNECTORS.

in small quantities, since they may easily lead to the formation of soap and speedily cause frothing. All colloidal bodies, including silicates, should be carefully excluded. As to the life of the Edison cell, the fact that in the run made the capacity had not been changed 1 per cent. after 500 miles gives reason for believing that the life of the battery will certainly not be short.

A peculiarity of the cells used in the experiments described is that they have an equal number of positive and negative plates, but Mr. Edison has recently altered this by assembling more positives than negatives in the cell. Both Mr. Edison's experiments and those of Mr. Hibbert have shown that the positive plates could not absorb all the oxygen contained in the negatives after discharge.

Long Distance Test of the De Forest Wireless Telegraph System.

On the morning of Saturday, December 5, a test was made between Fort Wright, New London, and Fort Schuyler, N. Y., a distance of about 100 miles, by the De Forest Company on behalf of the government. Three messages of about thirty words apiece were sent by General Greely, of the United States Signal Corps, from Fort Wright to Captain Reber, at Fort Schuyler. The particular interest of the test lies in the fact that certain conditions were imposed which made it very difficult to send a distance of 100 miles; namely, the height of the antennæ at the two stations was limited to 140 ft., and the power at the sending end to 3 kw. With such short antennæ and small power the sending of messages over this distance is an indication of the efficiency of the De Forest system.

The government is erecting two stations in Alaska about 100 miles apart, and General Greely wished to satisfy himself that messages could be transmitted over this distance under the conditions stated. Among those present at Fort Schuyler during the making of the test were General Greely and Captain Wildman, of the Signal Corps, and Dr. Ives and Mr. Athearn, the operator of the De Forest Company. At Fort Schuyler were Captain Reber, of the army, and Messrs. Easton and Hughes, operators of the De Forest Company.

New Integrating Wattmeter for Alternating Current Circuits.

The Westinghouse Electric & Manufacturing Company is now manufacturing an integrating wattmeter, called "Type A," which contains some new features in wattmeter construction, designed to give the greatest degree of accuracy, permanency of calibration and convenience in installation. In general the principles upon which it is constructed are the same as those formerly employed, the changes consisting in the addition of new, and the improvement of old, functions without displacing any of the characteristics which have become well known to the users of Westinghouse wattmeters.

One of the advantages claimed for Westinghouse wattmeters is the small amount of friction in the moving element due to its light weight and careful adjustment. In the new type this friction is still further decreased by the introduction of a highly polished steel ball in the bearing upon which the measuring disc rotates, shown at *C* in Fig. 2. The shaft to which the disc is fastened rests perpendicularly upon the ball, a cupped sapphire jewel with which the shaft is tipped forming the contact with it. A similarly cupped jewel is set into the end of the adjusting screw, which forms the lower half of the bearing, and the ball rests in the hollow between the two cups. The radius of the cups is greater than that of the ball, and the contact surfaces are thus made extremely small.

There are several advantages gained by the use of the new bearing. In the type generally used, containing a steel pivot, which rotates on a jewel, the pivot usually shows wear before the jewel is affected. In the new cup and ball bearing, the wear is distributed over the entire surface of the ball and is inappreciable, the high polish of the latter remaining unimpaired after long usage. There is also a lessened wear upon the jewels, as in this bearing there are two points of contact instead of one, and the wear is equally divided between them. If one of the jewels were destroyed and all of the additional benefit gained by introducing a ball thus nullified, it would still equal in efficiency the old style pivot bearing.

An additional advantage is gained by the slight orbital motion of the ball, which gives a rolling instead of a rubbing contact with the jewels, eliminating scratching of the surfaces. Vibration or shock from jarring the wattmeter simply cause the ball to roll in

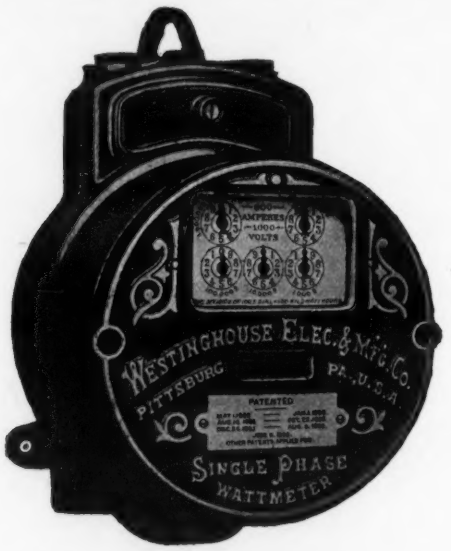


FIG. 1.—INTEGRATING WATTMETER.

the bearing. The extremely low friction loss permits a delicacy of adjustment and affords a sensibility to small currents otherwise unequaled, and of particular value when installations are running under light loads, a condition existing in the average plant the greater part of the time.

In this type of wattmeter there is a higher ratio of torque to friction and a greater torque per unit of weight in the moving element than in any other. This is gained by securing a high degree of efficiency in the magnets, and by reducing the weight and friction in the moving element as much as possible. To raise the torque by increasing the induction in the magnets is to incur a greater error through variations in frequency, voltage, wave form, power factor, etc. The proportions are, therefore, so arranged as to minimize the effect of such variations. A high torque secured, however, by increasing the weight of the moving parts increases the danger of jewel trouble, a source of much annoyance in wattmeters whose moving elements are heavy. In the new type the rotating disc and shaft weigh only about half an ounce, and the ball bearing still further increases its light running qualities.

If, in the course of long service, the wattmeter slows down on light loads, it can usually be restored to its normal efficiency by cleaning the ball and cup bearing, the wear not being sufficient to injure the polish of the surfaces. If this does not entirely remedy the trouble, the original calibration can be restored by means of a sliding contact, shown at *A*, Fig. 2, so placed on a high-resistance

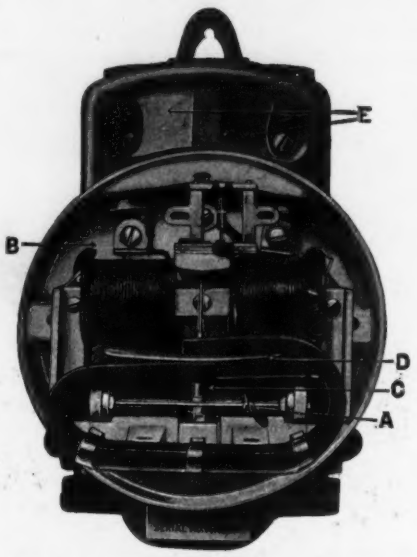


FIG. 2.—INTERIOR VIEW OF WATTMETER.

wire that altering its position varies the current in the shunt field and the compensation for friction on light loads. This provides an exceedingly simple and reliable friction compensation and one which can be manipulated by the purchaser.

The wattmeter adjusted for 133-cycle circuits is provided with an open loop, which can be connected and soldered in order to secure a readjustment for 60 cycles. Thus, if at any time an installation using a 133-cycle system is changed to the lower frequency, the wattmeters in use can be readjusted by means of the frequency and compensating adjustments shown in Fig. 2 at *B*, and the purchase of new wattmeters made unnecessary.

The adaptability of the new type is still further demonstrated by the fact that a wattmeter rated for 100 volts can be used without appreciable error upon a 50-volt circuit without any change whatever. This feature is of manifest advantage in providing wattmeters for installations using 50-volt currents, which will later be raised to the higher e.m.f.

The adoption of front connections adds to the ease with which the wattmeter may be installed or removed. The wires pass through the top into a terminal chamber, shown at *E*, Fig. 2, the lid to which is fastened at the front. The cover to the wattmeter is also secured on the front by two screws, which pass through to the back, and can be removed without detaching or disconnecting the wattmeter. The cover is sealed with wax before shipment and the terminal chamber is secured by a lead seal at the time of installation.

The wattmeter combines, in fact, the sturdiness of a field instrument with the delicacy of a piece of laboratory apparatus. It is shipped with all parts in operating position and fully adjusted, and with the case securely sealed in order that the original calibration and adjustment may remain undisturbed. Wattmeters having heavy moving elements, which must be removed from the bearing in shipment in order to protect the jewels, have no such advantage, for after the lineman has made the connections, a meter expert must remove the fastenings from the moving parts and make the adjustments. This makes the installation more expensive, and gives a greater liability of error in adjustment, since a higher accuracy cannot be secured by a man hampered by inconvenient locations, insufficient light and all manner of hard conditions. The expert work on the wattmeter is done at the factory, and any man who can make the connections properly can install it.

The Reid Fuel Gas Battery.

Mr. James H. Reid gave a public demonstration at Newark, N. J., December 2, of a battery which is claimed to solve the problem of electricity direct from fuel. Briefly, the method consists in conducting a fuel gas into a porous receptacle pervious to gas, but im-

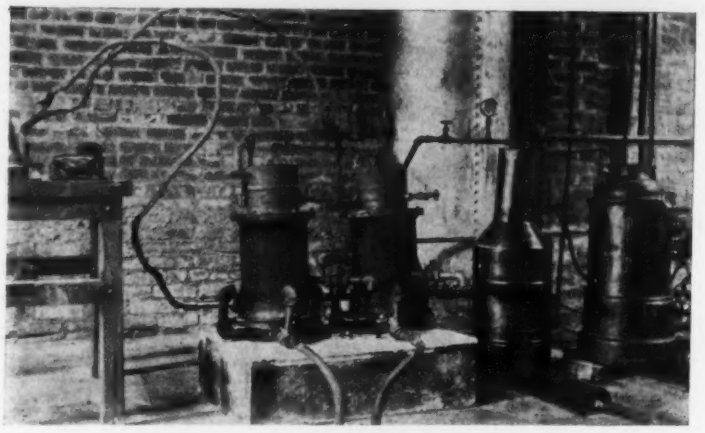


FIG. 1.—FUEL GAS BATTERY.

pervious to liquid; maintaining a heated liquid electrolyte at the opposite face of said receptacle; supplying oxygen to the heated electrolyte, and providing conductors for the developed electricity from the porous receptacle and from the liquid electrolyte. Minute subdivision and slow oxidation are said to be the conditions upon which the operation of the cell depends.

In point of fact, the apparatus appears to be nothing more than a heat battery, the conductor and fluid being maintained below the temperature of rapid oxidation, and unequal with reference to each other. In this case the efficiency would be limited by the second law of thermodynamics, this law applying to all heat transforming devices. In its simplest form and as shown at the demonstration, the cell is illustrated in Fig. 1. The cell (two are shown to the left on the engraving) is a cylindrical iron vessel filled with an electrolyte composed of sodium hydrate, calcium chloride and iron oxide, the electrolyte being

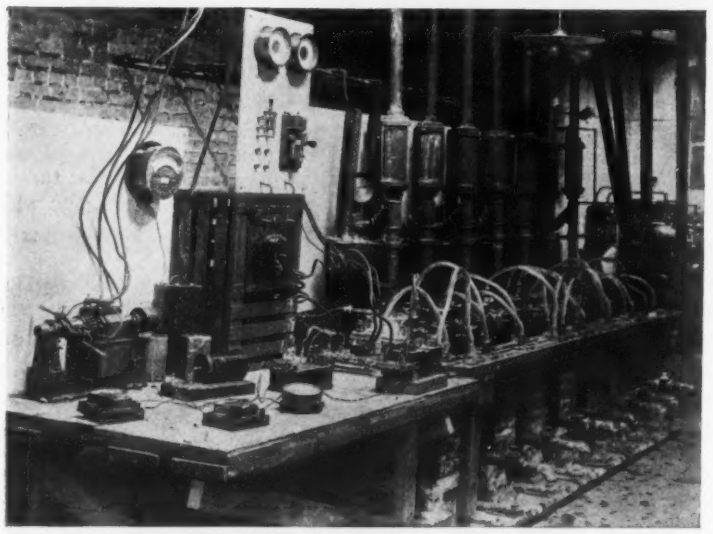


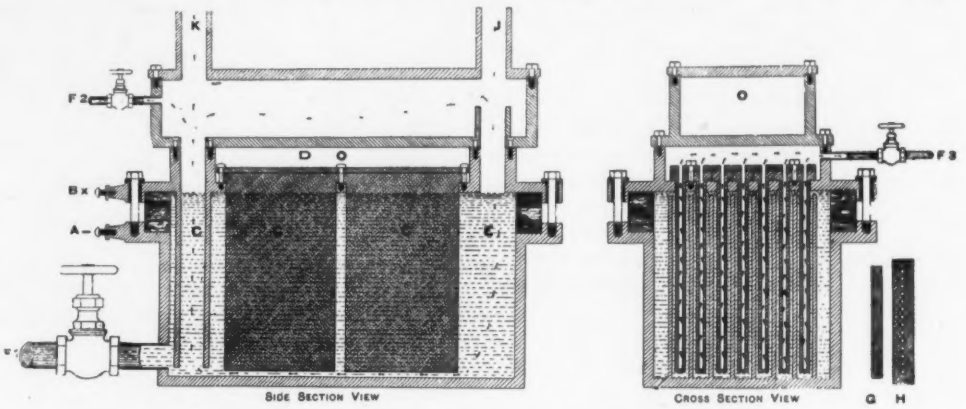
FIG. 2.—VIEW OF 60-HP MACHINE.

maintained at a temperature of 390° F. Penetrating into the electrolyte and insulated from the iron are hollow electrodes made of carbon.

The carbons are of positive polarity and the iron pot of negative polarity. Fuel gas is forced into the hollow carbons, and the contention is that it percolates through the porous walls of the carbons, the carbon and hydrogen of the gas uniting with the oxygen in the electrolyte or in the carbon wall, resulting in the production of electricity, which continues so long as the gas is supplied to the carbons and oxygen to the electrolyte.

Any form of fuel rich in hydrocarbons may be used. In Fig. 1 a gas producer is shown to the right, for converting a mixture of street sweepings and culm into gas. At the demonstration, however, illuminating gas mixed with air in the proportion of one part of gas to forty of air was used. The electrolyte was likewise heated by illuminating gas. An e.m.f. equal to .9 volt per cell was developed and maintained fairly constant so long as the gas was passed through under the proper pressure and the electrolyte maintained at a temperature of 390° F. The products escaping at the top of the cell were said to contain water in the form of vapor, carbon dioxide and carbon monoxide; but this was probably inferential since they burned when a lighted taper was applied. The inventor claimed that in a commercial plant these gases would be returned to the combustion chamber so as to recover the heat value of the carbon monoxide. He expected to thus eliminate the necessity of using additional fuel to supply the requisite heat to the electrolyte, this being supplied by the waste gases. The cells recover very rapidly from the effects of short-circuit. One ampere is said to be developed for every five square inches of surface exposed.

Early in the history of Mr. Reid's experiments he built a 60-hp machine which he said performed all the work expected of it, but failed in one particular—the porous carbons disintegrated. Since



FIGS. 3 AND 4.—SECTIONAL VIEWS OF GAS BATTERY.

then carbon from the electric furnace has been used. A view of this outfit is given in Fig. 2. With this outfit the inventor claims to have developed an electrical horse-power for every five feet of gas used, the calorific value of the latter being 650 B.T.U. per cu. ft.

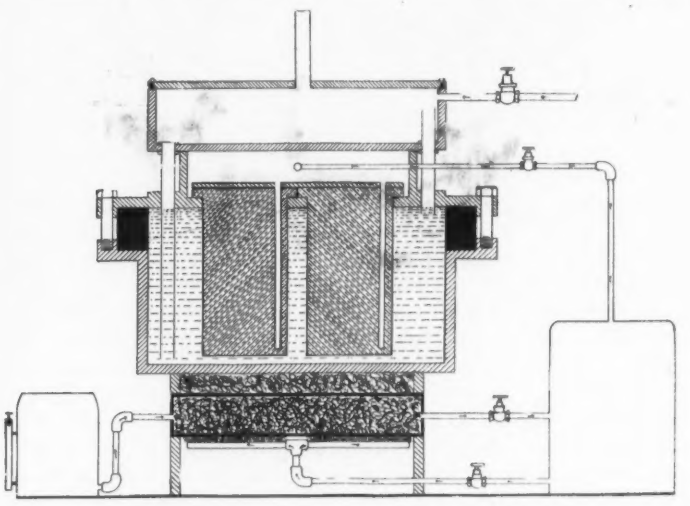


FIG. 5.—SECTIONAL VIEW OF GAS BATTERY.

The average efficiency of electric production by this method is claimed to be 45 per cent., as against 8½ per cent. with the steam engine. The expense of installing a commercial plant will, it is claimed, be about one-fourth of the first cost of present plants. The low voltage of each cell and the impracticability of placing enough of them in series for commercial wants other than for electrolytic

purposes, will, of course, render it necessary to use some form of transforming apparatus.

The form which a commercial plant will take is illustrated diagrammatically by Figs. 3, 4 and 5. Fig. 3 represents the containing vessel or shell and is the negative pole; *B*, the aerating and exhaust part of the apparatus being the positive pole; *C C* are the porous electrodes directly-connected to the positive pole, while *D* is the gas chamber into which gases are forced and allowed to percolate through the porous electrode into chamber *E*, which is filled to line *B*, with an electrolyte. This electrolyte is an oxidant. The cock marked *F1* is for convenience in drawing off the electrolyte, and *F2* is a water cock for cleaning out the aerating and expansion chamber. In Fig. 4 *F3* is a cock controlling the flow of gas, *G* is the bottom view of the electrodes, *C C h* is the top view showing gas inlets to electrodes *C C; I* shows the iron electrodes connected to *A* and forming the negative electrode in the electrolyte. The arrow marks in this cut show the flow of gas, and in Fig. 5 of the electrolyte to and from their openings; *J* represents the exhaust, and *K* is an intake of free air to maintain the balance of oxygen in the electrolyte.

We are informed that the Dynelectron Company, of 25 Broad Street, New York City, the holding corporation, is building a 100-hp outfit made up of ten cells, which it expects to exhibit publicly some time next month. This is claimed to be a practical and commercial apparatus and will be submitted to a committee of experts. It is stated that it will occupy a space 8 x 8 x 10 ft. long and will include besides the cells a complete gas generating plant. As the e.m.f. will be but 10 volts, a current of 7,460 amperes will be generated.

Brooklyn Ashes to be Electrically Hauled.

Contracts have been entered into for the purpose of carrying the ashes and street sweepings in Brooklyn over the Brooklyn Rapid Transit lines to the lowlands at Coney Island and Jamaica Bay. A unique feature of the work will be that all the handling will be done electrically, none of the material being touched by hand from the time it is shoveled into the carts of the street cleaning department on the streets until it is finally disposed of for filling in waste tracts of land in the outlying districts. By employing the new system the city expects to effect an annual saving of upwards of $80,000.

The American Railways Traffic Company has been incorporated under the laws of the State of New York with a capital of $1,000,000 for the purpose of undertaking the work. The president of the company is H. J. Hemmens, of the law firm of Beardsley & Hemmens, 54 Wall Street, New York. Charles J. Farrell is secretary

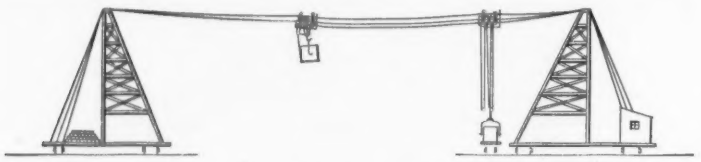


FIG. 1.—ASH-HANDLING APPARATUS.

and treasurer. The company has taken over the contract which H. N. Kennedy, formerly general passenger agent of the Brooklyn Rapid Transit Company, had secured from the city for the removal of ashes, etc.

Thirteen stations will be built on the Brooklyn Rapid Transit surface lines to receive the ashes. They will be located within a radius of about a mile from one another. To each of these stations the city horse carts will carry their collections from their respective districts. The carts will drive into the stations, which will be enclosed as to both roof and sides, to prevent the scattering of the ashes, etc. The material will be automatically shot into large steel bins fitted with light steel covers. These bins will each have a capacity of 10 cubic yards. Each station will have room for about 24 bins. The bins will remain covered except when the wagons are actually dumping into them. When filled they will be raised by an electric crane on to flat cars for conveyance to Coney Island or Jamaica Bay.

The electric crane for each of the stations will be of 10-tons capacity each. The span will be 35 ft. These machines will be built by the Shaw Electric Crane Company, of Muskegon, Mich. The cars will be built by the J. G. Brill Co., of Philadelphia. They will be regulation flat cars. Fifty will be employed in the work. Four bins will be carried on each car. On arrival at the ultimate destination each bin will be picked up by an aerial tramway system and carried along the wires to be dumped wherever desired. The tramways will be built on wheels so as to permit of their removal from place to place. They will be electrically-operated. One is to be built by the Lidgerwood Manufacturing Company, New York.

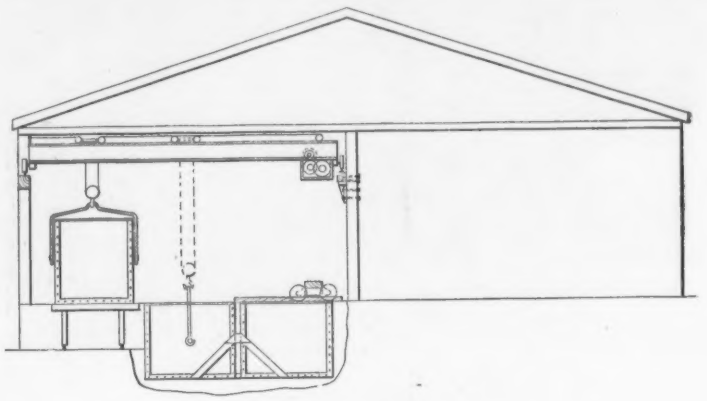


FIG. 2.—PLACING ASH BINS ON CAR.

The other is to be manufactured by the Carson-Trench Machine Company, of Boston, Mass.

Work on eight of the receiving stations has already been started. The locations are Ralph Avenue, near Atlantic Avenue; Fourth Avenue and Fourth Street; Third Avenue and Third Street; No. 224 Adams Street; Hopkins Street, between Marcy and Nostrand Avenues; corner of Broadway and Fulton Street; Fulton Street and Tompkins Avenue, and Fourth Avenue and Thirty-eighth Street.

The contract is for a period of five years. About 1,000,000 cubic yards of ashes, etc., are to be handled annually. This means about 500,000 tons. The contract price between the American Railways Traffic Company and the city is 35 cents per cubic yard. The saving to the city by the new system is expected to be nearly 25 per cent. The horse cart haul alone will be reduced 54 per cent. The new system will be in extensive operation by December 28, this year.

Work That Electrical Artisans May Do.

In regard to a trades union dispute over work that "electricians" or electrical workers are allowed to do, without causing a strike, the following is the interesting award of the trade arbitration committee that has considered the subject, in New York City:

"In New York builders shall do the cutting necessary for the installation of electric conduits, of all solid brick work, also of all fire-proofing where three or more conduits run together, and for all panels and cut-out boxes at their own expense.

"That electricians shall cut on all fire-proof partitions where less than three conduits run together, and may drill holes through floors or walls, and cut any brick work for slight changes.

"Contracts entered into prior to the date of this award shall be executed as heretofore. That is, if the cutting is in the electricians' contract, he shall employ his own men at his option, to cut. If in the builders' contract, he shall employ the men he now employs; but after the date of this award the cutting of solid brick work, and of all fire-proofing where three or more conduits run together, and all panels and cut-out boxes, shall be eliminated from the electricians' contract.

"Old or Repair Work.—Where cutting or piercing is through or on old walls, the electrician shall cut with whom he may choose. Where cutting is through or on new walls, the builder shall do the cutting necessary for the installation of electric conduits of all solid brick work; also, of all fire-proofing where three or more conduits run together, and of all panel and cut-out boxes, at his own expense, and electricians shall cut the fire-proofing partition where less than three conduits run together, and may drill holes through floors or walls, or cut any brick work for slight changes."

Circuit Breakers.

Some three years ago the General Electric Company placed on the market a line of carbon break circuit breakers. These breakers

FIGS. 1 AND 2.—CIRCUIT-BREAKERS.

have given such satisfaction that the company decided to extend and complete the line, and has recently brought out several new forms. This new line of circuit breakers is complete for all current capacities

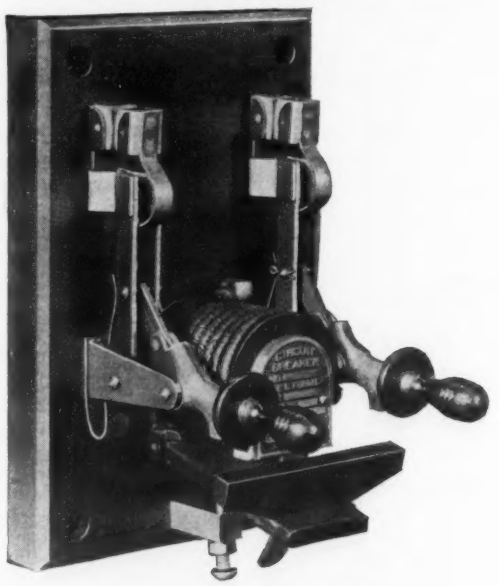


FIG. 3.—CIRCUIT-BREAKER.

from 1 to 10,000 amperes, and for all voltages up to 650. They embody many new ideas in circuit breaker construction, and are illustrated by the accompanying photographs.

The one illustrated in Fig. 1 is designed specially for heavy railway work, and is made in capacities from 800-10,000 amperes, and for voltages up to 650. It has been adopted by the Interborough Rapid Transit Company of New York City, as well as other large companies for use in their power stations. These breakers are very liberally proportioned, both electrically and mechanically, having ample carrying capacity and large contact areas, they are very reliable in operation, and are designed to close with small expenditure of power.

The type illustrated in Fig. 2 is also intended for heavy service, but is of smaller capacity, ranging from 75 to 800 amperes. The type shown in Fig. 3 is compact and simple, yet a very reliable device. It is made in various capacities up to 75 amperes, and for voltages up to 650 volts. Its exceedingly low price permits its use in places where switches and fuses have heretofore been used. This breaker is made in both single and double pole types, and either pole of the latter may be operated independently of the other.

A New Form of Bench Lathe.

The Cataract bench lathe which has recently been placed on the market, combines various features which should commend it to the consideration of the careful purchaser. In its design the question of ultimate worth rather than first cost has been considered paramount. The lathe has a newly designed head, containing unique features and radical departures from old principles. The spindle has been made ample heavy to resist any unusual strain to which the chuck may be subjected, and still retain its exactness and truth. The distribution of weight in the spindle of the new No. 3 head is mechanically perfect. It has no threads upon it, and, therefore, can be hardened and ground true by the inside or hole and can be removed, cleaned and adjusted most easily, an advantage not to be overlooked by the practical mechanic. The outer ends of the spindle and journals are protected by felt washers, held in place by dust caps which screw on the head casting or housing so that they remain in place or may be removed and cleaned with ease. No dirt reaches the spindle journals between the housings, for the reason that the cone comes close at one end and the ball bearings at the other, with the result that the bearings are absolutely protected from dirt. (Fig. 1.)

The journals are made from a hard quality of cast iron lapped and nicely fitted, and the adjustment for wear is sufficient for years of constant use. After a very little use these cast iron bearings become glazed similar to the cylinder of an engine, and being more

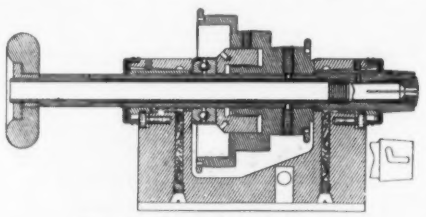


FIG. 1.—BENCH LATHE.

porous than hardened steel, they present a better surface for retaining oil, thus they never ring or cut like hard steel running against hard steel. They can be replaced quickly if necessary at small expense and still retain perfect alignment.

By referring to the illustration, it can be seen that the journals are tapered on the outside, and parallel on the inside, which bears against the spindle, thus allowing the spindle sufficient end shake to wear smooth without affecting the alignment. The adjustment of the journals is accomplished in a most simple and effective manner by a single substantial screw, which holds them in place and also tightens or loosens them. Being accessible by the mere removal of dust caps, there is no reason why the journals in this lathe head should not be as closely fitted at all times as may be desired. The end pressure in the lathe is reduced to a minimum by the ball-bearing end thrust properly arranged, leaving practically the whole traction of the belt for cutting, drilling or facing.

The end shake of the head is provided for between the journal housings or head casting independently of journal adjustment. This is attained within the cone pulley by a threaded nut fitting closely into the cone pulley independent of the thread and secured by set screw. Thus the nut may be turned at will by loosening a set screw and by placing a pin in angular holes, which lead past the outer flange of the cone pulley. One support for the ball bearing is direct

with the rear housing, the other one being the large nut within the cone. This gives two flat surfaces, true as a perfectly flat shoulder, the ball bearing being between these and adjusted as closely as the work may require. The resistance offered by this form of journal and ball thrust is the least possible without employing roller bearings which are not suitable for lathe spindles.

The oiling devices for this lathe are features of special value. The holes are one-quarter inch in diameter, and journals are cut out to admit a wick which fills the oil wells, also the recesses at the bottom of journals. The oil is admitted to this wick through oil grooves that are turned into the housings, the oil cups being placed back of the housing out of the way. There being no hole through the boxes, the oil must go through this channel and up through the wick, thus

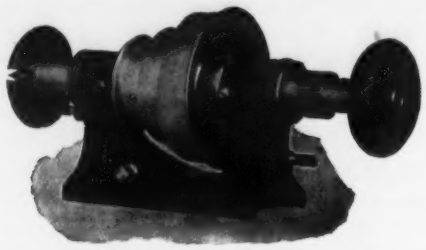


FIG. 2.—BENCH LATHE.

keeping the dirt from the journals and securing the great advantage of having only filtered oil reach the journals. Moreover, the oil wells constantly supply the spindle, and in just sufficient quantity to secure perfect lubrication.

Everything can be thoroughly cleaned without altering an adjustment of the journals or end shake, by taking out the driving screw and drawing the spindle forward, lifting out the cone and ball races, removing the wick and replacing all. This lathe is manufactured by Hardinge Brothers, Chicago, Ill.

Controllers for Cranes and Steel Mill Work.

The application of electric motors to heavy cranes and such work as is done around steel mills requires controllers of a very efficient and durable type. The Case Manufacturing Company, of Columbus, O., has devoted its energies specifically in this direction, and is now introducing the controller herewith illustrated in Figs. 1, 2, 3 and 4.

The design of the controller is a departure in various respects from previous practice in such work, and the contacts are of large area and made of hammered copper and phosphor bronze. The principles involved are similar to those of the old knife switch with a hard

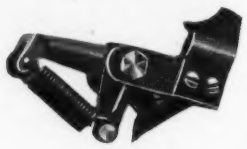


FIG. 1.—DETAIL.

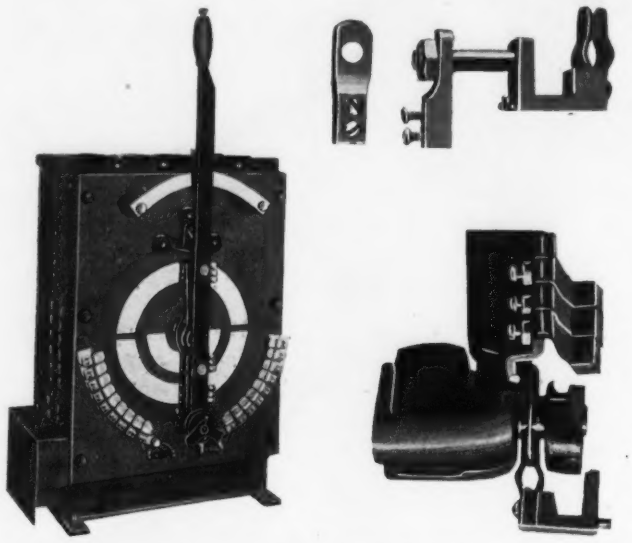
copper disc passing between them in a constant shearing motion. This disc is always in contact with at least two of the constant blades, thereby reducing the sparking between steps to almost nil. The first step is provided with a quick-breaking device, which makes it impossible to prolong the arc by shutting the controller off slowly. The reversing circuit is open only after the lines have become dead through the action of the quick-breaking device, as noted above.

As before stated, the main contacts consist of phosphor bronze knife blade contacts which are very easy to replace, the removal of two machine screws being all that is required to replace each set. They are mounted on a slate slab, and the connection to the resistance is accomplished by means of an ordinary brass terminal.

The roller knife blade is made of a hammered copper disc rotating in a strong magnetic field, the arc on the break being at direct angles to the magnetic lines of force across the air gap of only one-half inch. This construction in connection with the quick breaking device makes it impossible to maintain an arc between the contacts.

The blow-out coils are wound on a form and dipped in an insulating varnish and thoroughly baked, then served with friction tape and painted with an insulating paint. Use has been made freely with mica and asbestos, with a view of reducing the chance of grounds and short circuits to a minimum. The contacts for reversing the motor are of cast brass of large surface, and machined true. The fingers for the reversing contacts are made of hammered copper very large and machined to a true bearing. They are carried on phosphor bronze springs of large sectional area, and in the large sizes the "pig-tail" connector is used to relieve them of the load. They are provided with a practical adjustment of tension which is very easy to operate. They are not called upon to act in the capacity of a switch, as the circuit is always opened before they come off the contacts.

The resistance consists of galvanized iron wire coils on asbestos tubes supported at either end on a porcelain bushing through a cast-



FIGS. 2, 3 AND 4.—DETAILS OF CONTROLLER.

iron channel, the ends of the coil being screwed on to a malleable iron terminal. The cross connections are effected by means of copper ribbon "jumpers" placed at the top and bottom of the controller. In order to replace a coil, all that is necessary is to remove two nuts on either end and the coil comes out without disturbing any of the other coils or any connections. This makes replacement readily accomplished. The wiring from the resistance coils to the controller is done with underwriter's wire, and asbestos and mica are used freely.

The terminals are all brought to a slate board at the base of the controller, and all that is necessary to install the controller is to run one wire from each line, two from the fields, and two from the armature circuit to the terminal board; and the apparatus is then ready for operation.

Where specially close regulation is required, such as handling cores, etc., by a crane in foundry work, an auxiliary lever is put on the controller by means of which double the number of variations are secured to control any series motor from 10 per cent of its rated speed to the maximum speed under any load up to its rated capacity.

A New Fuseless Rosette.

FUSELESS ROSETTE.

The rosette herewith illustrated is adapted particularly for concealed work, and is said to be the only fuseless rosette made specially for this class of work. A very neat dome gives ample room for the knot in the cord and completely covers all contact pieces and inside screws. Heavy porcelain walls separate the "leading-in" wires, making short-circuiting impossible, and adapting the rosette for use with 250-volt work. Its extreme neatness and ease of wiring should make it popular with the trade. This rosette is made by the H. T. Paiste Co., of Philadelphia.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The stock market was strong on covering of short contracts, due to manipulation and the absence of further liquidation. Pennsylvania Railroad and United States Steel preferred were leaders in the advance, but the standard railroad stocks, the tractions and the industrials all show a material improvement. The firmness of money rates was no obstacle to the advance. General Electric, Brooklyn Rapid Transit and Amalgamated Copper were prominent features. The activity in Brooklyn Rapid Transit is shown in the fact that 277,745 shares changed hands during the week, the range of prices being between 39⅛, the lowest, and 49⅞, the highest, the closing price being 48⅛, thus gaining 8⅝ points net. General Electric made a gain of 5½ points, closing at 160, which is two points below the highest and five above the lowest. Metropolitan Street Railway closed at 120, this being a net gain of 3⅜. Westinghouse common showed unusual activity, 10,670 shares having been sold. The closing price was 148¾, this being an increase of 10¾ points; the preferred stock closed at 195, thus making a net gain of 25 points. Western Union made a gain of 2¼ points, closing at 87⅜. The Boston market was firmer during the week, Massachusetts Electric closing 4¼ points higher, with preferred up 1½ points. The copper stocks were held very steady. Following are the closing New York quotations of December 8:

NEW YORK.

	Dec. 1	Dec. 8		Dec. 1	Dec. 8
American Tel. & Cable	75	78	General Electric	156	163¾
American Tel. & Tel.	126	127	Hudson River Tel.	..	..
American Dist. Tel.	25	24	Metropolitan St. Ry.	117¾	120⅛
Brooklyn Rapid Transit	39¾	46⅛	N. E. Elec. Veh. Trns.	..	..
Commercial Cable.	145	152	N. Y. & N. J. Tel.	..	..
Electric Boat	21	20	Marconi Tel.	..	..
Electric Boat pfd.	45	49⅛	Western Union Tel.	88	87⅛
Electric Lead Reduction	⅝	⅝	Westinghouse com.	140	156⅛
Electric Vehicle	5⅛	5¾	Westinghouse pfd.	170	185
Electric Vehicle pfd.	8	8			

BOSTON.

	Dec. 1	Dec. 8		Dec. 1	Dec. 8
American Tel. & Tel	126	127	Western Tel. & Tel. pfd.	80	*82
Cumberland Telephone	*115	*115	Mexican Telephone	1⅛	1¼
Edison Elec. Illum.	241½	240	New England Telephone	120	120
General Electric	155	*164	Mass. Elec. Ry.	19	20
Western Tel. & Tel.	7⅛	7⅛	Mass. Elec. Ry. pfd.	77	75

PHILADELPHIA.

	Dec. 1	Dec. 8		Dec. 1	Dec. 8
American Railways	40	42	Phila. Traction	95	95⅛
Elec. Storage Battery	49	53	Phila. Electric	5⅞	6⅛
Elec. Storage Battery pfd.	49	53	Phila. Rapid Trans.	11⅛	11
Elec. Co. of America.	7⅜	8			

CHICAGO.

	Dec. 1	Dec. 8		Dec. 1	Dec. 8
Central Union Tel.	..	..	National Carbon pfd.	87	86
Chicago Edison	..	144½	Metropolitan Elev. com.	17	17
Chicago City Ry.	165	160	Union Traction	5	5⅛
Chicago Tel. Co.	..	..	Union Traction pfd.	28	28
National Carbon	20	25			

*Asked

SAFETY WIRE & CABLE ABSORBED.—Announcement is made that the National Steel & Wire Company has increased its capital stock by $1,500,000 preferred, to $4,000,000, and $1,500,000 common, to $4,000,000, for the purpose of absorbing the Safety Insulated Wire & Cable Company, of Bayonne, N. J. The National Company has been furnishing the Safety Company with a large portion of its wire requirements. There is outstanding $1,250,000 preferred stock and $1,500,000 common stock of the Safety Company, which will be exchanged for National Steel & Wire Company stock, share for share, and, in addition, $250,000 of National Company preferred stock will be sold at par for cash. The working capital of the combined companies will be $1,600,000, equalling 20 per cent. of the entire capital. Earnings of both companies, after charges for depreciation, applicable to dividends on the combined common stock of the two companies, are at the rate of about 10 per cent. The financial plan has been underwritten by interests controlling both companies.

DIVIDENDS.—The board of directors of the Westinghouse Air Brake Company has declared the regular quarterly dividend of 2½ per cent. and an extra dividend of 3½ per cent., payable to stockholders of record January 11, 1904. The board of the Detroit United Railway has declared the regular quarterly dividend of 1 per cent. The regular quarterly dividend of 1½ per cent. on the capital stock of Manhattan Railway Company will be paid January 1. Western Union's executive committee has recommended the declaration of the regular quarterly dividend of 1¼ per cent.

GERMAN ELECTRICAL CONSOLIDATION.—A cable dispatch from Berlin of December 5 says: "It was decided to-day to amalgamate the Allgemeine and Union Elektricitäts Companies, which had already formed a working agreement. The Union Company's 24,000,000 shares will be transformed into 16,000,000 shares of the Allgemeine shares, making the capital of the latter $19,000,000.

CHANGES OF CAPITALIZATION.—The Chase Electric Construction Company, Chicago, has decreased its capital stock from $10,000 to $1,000. The Gregory Electric Company, Chicago, has increased its capital stock from $100,000 to $300,000. The Northwestern Electric Company, Chicago, has increased its capital stock from $5,000 to $25,000..

NEW YORK TROLLEY EARNINGS.—The consolidated statement of the Interurban Street Railway of New York for the September quarter shows $5,570,212 gross and $2,808,612 net. The gross shows a gain of $198,521 over 1902. The surplus is $163,377, showing an increase of $17,007 over 1902.

CHICAGO ELEVATED.—The Lake Street Elevated, Chicago, shows $834,059 gross earnings for 1903, a gain of $40,000 over 1902. The net was $368,568, but after charges, taxes, etc., there was a deficit of $49,170.

PORTO RICO TROLLEYS.—The Vandergrift Construction Company, of San Juan, has closed its doors owing to inability to raise funds to carry on its $3,000,000 trolley construction plan.

Commercial Intelligence.

THE WEEK IN TRADE.—The cold weather and the advent of the holiday season have brought about a more normal tone in public sentiment and a consequent better feeling in retail trade. Some industries are in remarkably good shape with record-breaking shipments for the season, but the advance in raw cotton is a matter of concern to the trade. In the iron and steel trade, shut-downs more than offset resumptions. There is more confidence in the market for the cruder forms of iron and prices are steadier. Winter weather is causing a slowing-down in many lines of building, and lumber; other building material and hardware are rather less active for this season. Lake navigation is practically closed, with a larger movement of grain and coal, but a much smaller ore trade than in 1902. Railway operations are still active with an increase of about 5 per cent. shown in gross receipts over November a year ago. Monthly failure statistics are more favorable in that failures and liabilities are fewer and smaller than in October, though in excess of a year ago. On the whole they seem to indicate less strain in general business than in the month previous. Collections are better in some localities, but in general are somewhat sluggish. Prices of agricultural staples are all stronger. Finished iron and steel products are little changed, and among other metals copper is dull and weak, but in better export demand. Prices for all grades of raw copper have undergone material shrinkage during the past month. The receding tendency was marked throughout almost the entire month of November and nothing occurred to check the gradual decline. In Europe, however, the buying has been on a better scale than in this country and a number of good-sized lots were taken by foreign consumers during the month. As regards domestic demand, there has been a decided lack of animation for some time past, and sagging prices have so far failed to stimulate general buying on a large scale. The foreign visible supply on December 1 was 12,743 long tons, which is the smallest since 1899. During the week just closed there was a further decline in prices in New York, the closing quotations being 12⅛ to 12½c. for Lake, 12 to 12¼c. for electrolytic, 11¾ to 12c. for cathodes and casting stock. Exports of iron and steel are growing. The chief cause of the increase in October exports was the large movement of cotton, now being reduced by high prices; but it is noteworthy that all classes of exports show increases of larger or smaller amounts. The business failures for the week ending December 3, according to *Bradstreet's* compilation, aggregated 239, against 167 the week previous, and 185 the corresponding week last year.

A VIEW OF AMERICAN EXPORTS.—The British *Board of Trade Journal* for December prints a warning to British manufacturers from Seymour Bell, the British commercial agent in the United States, prophesying an extensive invasion of the British markets by American firms in the near future. Mr. Bell writes that the decreasing demand in the United States for many classes

of manufactured goods indicates that American firms will soon be looking abroad for markets in which to dispose of their surplus products at almost any price. "It will be well, therefore," says Mr. Bell, "to bring before British manufacturers and shippers in an unmistakable manner the progress made in recent years by American exporters in securing a hold on the markets within the British possessions, particularly for certain classes of goods which could be manufactured in the United Kingdom." Mr. Bell asserts that the great extension of their plants by American manufacturers in recent years was necessitated by the home demand, which has already begun to fall off, and hence he forecasts an extensive "dumping" of American goods in British markets. He says that while the total of American exports during the past year has decreased 4.6 per cent., American exports to the British possessions have increased 17 per cent., and this, Mr. Bell adds, is a decidedly larger increase than is shown in the statements of exports from the United Kingdom.

AMERICAN BRIDGE COMPANY.—Hereafter the head offices of Post & McCord, composed of officers of the American Bridge Company and the Empire Bridge Company, of New York, who have resigned, will be in the Flatiron Building. The business of Post & McCord and the American Bridge Company will be separate and distinct, it was stated, as they are separate corporations. William H. McCord, former vice-president of the American Bridge Company, is president of the new company. The office of vice-president has been abolished by the American Bridge Company, and its duties, which related to the finances of the company, will be performed after January 1 by other officials, when the headquarters of the corporation are to be removed from Philadelphia to Pittsburg. The office of Erection Superintendent of the American Bridge Company of New York, formerly held by John McCord, will be held by him in the Post & McCord Company.

AUTOMOBILE SUPPLIES IN ST. LOUIS.—The A. L. Dyke Automobile Supply Company, 2108 Olive Street, St. Louis, Mo., has just completed arrangements to expand its business by introducing into the business new capital, and the employment of several salesmen to cover the territory so long flooded with catalogues and other matter. Several well-known residents of the city have become associated with Mr. Dyke. Messrs. F. H. Britton, Roy F. Britton and Charles Peters will become directors of the new company. The capital will be increased from $10,000 (its present authorized capital) to $25,000, fully paid. The company is seeking larger quarters in the business section of the city in order to handle the trade of the coming season. It will start on the road several salesmen experienced in the automobile supply line and its prospects are in every way satisfactory.

AUXILIARY STEAM IN CALIFORNIA.—The California Central Gas & Electric Company are planning the installation of a 500-hp auxiliary steam plant at Petaluma in the near future. This is to provide against the possibility of a break-down in their high-potential transmission line, and with it they intend to supply Santa Rosa, Petaluma, San Rafael and Napa with electric current in case the unexpected happens. This plant will also furnish power for the projected Petaluma and Santa Rosa electric railway in case an accident should happen to their power plant, which is to be located at Sebastopol. At the present time auxiliary steam plants are maintained at the various towns, and this one is planned in order that one plant may supply all the current in case of a break-down and reduce the expense of maintaining four separate plants.

PROJECT TO SUPPLY POWER TO EL ORO MINES.—Mexican advices state that H. H. Filey, resident manager and chief engineer of the Guanajuato Power & Electric Company, which American concern last month completed the construction of its 60,000-volt power transmission line—the second longest in this hemisphere—between the River Douro and the Guanajuato mining district, a distance of some 120 miles, is now at Zitacuaro for the purpose of making an estimate on the cost of power transmission between that point, where there is said to be abundant water power, and El Oro and the country adjacent. Zitacuaro is located about 50 miles from El Oro, the most prominent mining center in the republic.

EQUIPMENT FOR PRESBYTERIAN HOSPITAL.—The Presbyterian Hospital, at Seventieth Street and Lexington Avenue, New York, is to be equipped with a new power plant. The Ball Engine Company, of Erie, Pa., through Woolston & Brew, has secured the contract for the engines. There will be three capable of developing 200 hp each. The generators have been ordered from the Northern Engineering Company, 95 Liberty Street. They will be built by the Commercial Electric Company, of Indianapolis, Ind. There will also be three Commercial motors of 25 hp each, two of 5 hp each and one of 3-hp capacity. These motors will be used for ventilating purposes and for driving laundry machinery.

BRIDGE ILLUMINATION CONTRACT.—The Norden-Bittner Electric Company has the contract for the illumination with electric lights of the new Williamsburg Bridge on the East River, New York City, on December 19. Nearly twenty miles of wire will be used in stringing the lamps, which run toward 20,000 in number. The spans, cables, towers, anchorages and approaches will be outlined in white light. In the center of the bridge two immense American flags 100 ft. long, one on each side, will be outlined in red, white and blue lamps. At the approaches on each shore the city's coat of arms will be similarly picked out. Lamps of 8 cp will be used.

SOME HOLTZER-CABOT ORDERS.—The Holtzer-Cabot Electric Company, 143 Liberty Street, New York, has just secured a contract for 25 motors from the International Automatic Music Company, 2 West Twenty-ninth Street, New York. The motors will be of special make and of ⅙-hp capacity each. They will be fitted with an automatic device for use in operating automatic pianos. The Holtzer-Cabot Company has also been awarded a contract for the complete Sturtevant blower outfit for one of the United States battleships now under construction in the Brooklyn Navy Yard. There will be 21 motors varying from 2 hp to 5 hp each.

LONG MICHIGAN TROLLEY.—An electric railway to be known as the Detroit, Flint & Saginaw Railway, is proposed. The road will extend from Saginaw to Flint and from Frankenmuth to Vassar, a total of about 45 miles of single-track road. Preliminary surveys will be pushed forward and a report submitted to the company within 60 days by the Arnold Electric Power Station Company, engineers and contractors, of Chicago, Ill., which has been retained as consulting engineers. The specifications to be prepared will cover the buildings and entire power station equipment distributing system, and the sub-stations.

NEW YORK CITY LIGHTING.—The New York City authorities have rejected all lighting bids save one and the companies will also have to sue for the lighting done during this year unless they consent to cut their bills. The allegation is that the price is unduly high. The electric lights are thrown out in their entirety, the rate being $146 per year for each arc light. During the year 1903 the appropriation for lighting the city was $3,306,346.23, while the appropriation for 1904 in the new budget is $3,250,000.

BOILERS FOR NEW YORK CENTRAL.—As already noted, the boiler order for the New York Central equipment has gone to the Babcock & Wilcox Company for the two power houses. The contract includes 48 boilers of 625 hp each, equipped with Babcock & Wilcox superheaters, to give a superheat of 200°. The boiler working pressure is 200 pounds. The Babcock & Wilcox Company has also received a large order for boiler equipments from the New York Edison Company.

WESTINGHOUSE GAS ENGINES are to be adopted in a new central station now under erection at Berlin, Ont. The initial installation will aggregate 460 hp, comprising three 13 x 14, three-cylinder, 125-hp and one 11 x 12, three-cylinder, 85-hp vertical engines. These engines will operate on city illuminating gas of 650 B.T.U. calorific value, and drive direct-current generators for furnishing municipal lighting.

LINCOLN (NEB.) TROLLEY FORECLOSURE.—The Lincoln Traction Company's property, comprising practically the entire street car system of the city, was sold December 1 at auction on foreclosure proceedings to satisfy a tax lien of the city of Lincoln. The property was purchased by Charles A. Freuauff at the price of $1,160,000.

EQUIPMENT FOR MEXICAN QUARRIES.—Considerable electrical equipment will be installed in large marble quarries near Monterey, Mexico. All the drills will be electrically-operated, as well as various other machinery. C. J. Bauderer, of Monterey, is primarily interested in the properties.

ANOTHER MEXICAN HYDRAULIC PROJECT.—Manuel Cuesta Gallardo, of Guadalajara, is interested in a project to construct a large hydraulic plant between the city of La Barca and the Ateguiza hacienda on the Santiago River, State of Jalisco.

BALL ENGINE ORDERS.—The Continental Coal Company, Columbus, Ohio, is installing a 400-hp engine purchased from the Ball Engine Company, Erie, Pa., and has ordered a duplicate engine from the same company. Trinity College, of Durham, N. C., has recently purchased a Ball automatic engine from the Ball Engine Company.

MEXICAN LIGHTING PROJECT.—It is proposed to install lighting plants in a number of towns in the State of Michoacan, Mexico. Jose Maria Barragan, of Jiquilpan, can give further information.

CHICAGO TELEPHONE COMPANY shows a gain in subscribers during November of 1,668. The total of Bell subscribers now connected in that city is 99,570.

KILBOURNE & CLARK CO., of Seattle, Wash., has secured a contract for the erection of a new electric lighting plant at Port Angeles, Wash.

General News.

THE TELEPHONE.

BIRMINGHAM, ALA.—The Farmers' Mutual Telephone Company is the name of a new company just formed here.

ATLANTA, GA.—The Columbus Automatic Telephone Company is installing a large plant in this city and has already expended about $100,000.

PEKIN, ILL.—The Pekin Telephone Company has increased its capital stock from $10,000 to $75,000.

CONCORD, ILL.—The Home Telephone Company has increased its capital stock from $10,000 to $16,000.

ROBERTS, ILL.—The Lyman Telephone Company has been incorporated; capital, $5000. Incorporators: Chris Anderson, F. S. Diller, G. W. Maddin.

MEROM, IND.—The Merom Telephone Company has organized and incorporated with a capital stock of $10,000. George W. Stanley, W. J. Cooper and Winfred Reid are the incorporators.

ALICE, IND.—The exchange of the Knox County Telephone Company maintained here was burned recently. It was temporarily installed in another building. The officials contemplate erecting a new building and installing a new switchboard.

TIPTON, IND.—M. W. Pershing, postmaster, and editor of the *Tipton Times*, has won for himself fame that has spread far and wide. He has a number of farm lines running out into Tipton County. The Indianapolis papers get into Tipton about 6 o'clock. The telephone editor takes these papers, clips the headlines and prepares a careful synopsis of their contents and then at a convenient hour after supper he connects with all his lines and gives a prearranged call that brings every farmer to his telephone. Editor Pershing then proceeds to read to the farmers his summary of the latest news which is followed by weather reports and produce prices. In this way the farmers know the chief happenings of the world almost as soon as the residents of large cities. Mr. Pershing also notifies patrons if any mail or telegrams are in the office addressed to them and often they come immediately for the same.

LOGAN, IA.—The Woodbine Telephone Company has increased its capital stock from $25,000 to $50,000.

COUNCIL BLUFFS, IA.—The American Telegraph & Telephone Company will remove its terminal station from this city to Omaha, Neb.

POCAHONTAS, IA.—The building containing the exchange of the Mutual Telephone Company in this place was destroyed by fire recently.

DES MOINES, IA.—The Lanesboro Mutual Central Telephone Company, with a capital stock of $1200, has been incorporated by the Secretary of State.

BOONE, IA.—The Odgen Telephone Company's system at Odgen has been purchased by the Boone Telephone Company and over 400 subscribers will thus be added to the Boone Company's service.

RIVERTON, IA.—The telephone plant at this place, owned by the Tabor City Telephone Company, has been sold to a recently organized mutual telephone company. The plant consisted of 47 telephones with about 12 miles of pole line. The system will be greatly extended.

BALDWIN, KAN.—The Baldwin Telephone Company has been incorporated with a capital stock of $5000.

FRANKFORT, KY.—The Eminence Home Telephone Company, of Henry County, has been incorporated with a capital stock of $25,000, by William Callahan, W. B. Wilson and I. B. Callahan.

DEXTER, ME.—The Farmers' Telephone line is being built by the farmers of Gilmans Corners and Silver Mills.

POINT LOOKOUT, MD.—The Southern Maryland Development Company has a project to build a telephone line from Point Lookout to Upper Marlboro, where a connection will be made with the Chesapeake & Potomac Company, which has made arrangements to establish an exchange.

HART, MICH.—The stockholders of the Oceana County Bell Telephone Company have accepted the proposition of the Mason County Telephone Company to purchase the latter. The two properties will be merged.

FOLEY, MINN.—The Maple Leaf Telephone Company will establish an exchange here.

MOORHEAD, MINN.—The Red River Telephone Company, of Moorhead, has been incorporated with a capital stock of $50,000, the incorporators being P. H. Lamb, L. H. Baker and Leslie Wetter.

AUSTIN, MINN.—On Dec. 1 the Interstate Telephone & Telegraph Company, of Austin, formally opened its exchange for service. The plant is remarkable in many respects. It is an all cable plant with no cross arms or bare wire, each pole being equipped with a small terminal, so that pairs in the cable are available at every pole. A number of the pairs are in multiplex so they are available at more than one pole, which makes the distribution very flexible. The plant has been examined by leading telephone engineers, who state that it is a distinct advance in telephone construction, and will be very economical to operate. The equipment is of the common battery multiple switchboard type, with selective indicating keys for selective party line work. The plant starts in operation with one telephone for every 12 inhabitants in the city, which, it is said, breaks all former records. The engineering and management have been under the supervision of L. W. Stanton, consulting and constructing telephone engineer, of Cleveland, Ohio.

HANNIBAL, MO.—The electrical workers employed by the Hannibal exchange of the Bell Telephone Company and the Bluff City Telephone Company on Dec. 1 struck for an increase in wages. The Bluff City Company adjusted its differences with its workmen and the latter returned to work at once, but the employes of the Bell Company are still out. An advance of 25 cents a day for those employed by the day and $5 per month for those working by the month is sought. The new scale adopted is as follows; Linemen, $2.75 per day; assistant foreman, $3 per day; city foremen, $3.25 per day; trouble men, $70 per month; switchboard men, $85 per month.

VESTA, NEB.—The Crab Orchard Telephone Company has extended its lines and is putting in telephones to connect Vesta with the Crab Orchard exchange. When finished the exchange will have about 300 country telephones.

FREMONT, NEB.—Because the Fremont Independent Telephone Company has attempted to raise its rates 50 cents per instrument, efforts have been made in the City Council to annul its franchise. The Company was granted a franchise several years ago in which was stipulated that the rating for business houses was not to exceed $2 and residences $1. The company put in a good system costing about $45,000, but found that it could not do business at the stipulated rates. It has been announced that a stock company among the grocers is about to be formed to establish a new line.

CROWN POINT, N. Y.—The Crown Point Telephone Company has been incorporated with a capital stock of $3000. The incorporators are Jas. E. Pond, C. H. Wilson, Crown Point, and F. C. Pond, Schroon Lake, N. Y.

POUGHKEEPSIE, N. Y.—The State Line Telephone Company has increased its capital stock from $1,000,000 to $10,000,000. The Dutchess County Telephone Company is affiliated with the State Line Company and the local system will be extended all over Dutchess County.

PLATTSBURG, N. Y.—The Clinton Telephone Company, an independent concern, has been organized by the election of the following-named officers: J. H. Griswold, president; B. S. Ramsay, vice-president; J. S. G. Edwards, secretary. The company will be ready for business by July 1 next year.

ASHEVILLE, N. C.—The Asheville Telephone & Telegraph Company, representing the merger interests, has been chartered with a capital of $300,000, by C. R. Craig, W. S. Proctor and others.

COLUMBUS, OHIO.—The Middlepoint Home Telephone Company, of Middlepoint, has been incorporated with a capital stock of $60,000.

HASTINGS, OHIO.—The Hastings Telephone Company has been incorporated with a capital stock of $3000. Directors: F. Frank, D. J. McCreedy and others.

URBANA, OHIO.—The Independent Telephone Company will make extensive improvements to its system. A switchboard of larger capacity than the present one will be installed.

SHAWNEE, OKLA.—The Independent Telephone Company has completed a metallic circuit to Denison and Sherman, Tex.

PITTSBURG, PA.—The Lower Luzerne Telephone & Supply Company has increased its capital stock from $7500 to $20,000.

ABERDEEN, S. D.—The Dakota Central Telephone Company has decided to expend about $150,000 in extending its line into South Dakota.

CHATTANOOGA, TENN.—The long distance telephone line which is being constructed from this city to Cincinnati by the American Telephone & Telegraph Company is about completed. When the line is finished it will give direct telephone communication between Chattanooga and Asheville, Lexington and Cincinnati.

BRYAN, TEX.—The Bryan Telephone Company will build a line between this place and the town of Mumford.

SMITHVILLE, TEX.—The Smithville Telephone Company has been organized here with a capital stock of $10,000. H. C. Schumacher is president.

NAPLES, TEX.—A steady growth is reported by the Naples Telephone Company which has 56 subscribers. A Kellogg switchboard of 150 drops is used.

GONZALES, TEX.—A 300-drop American Electric switchboard is operated by the Gonzales Telephone Company which has 250 subscribers and 200 miles of toll line. The rates are $1.50 and $2.50 per month.

DAINGERFIELD, TEX.—The Daingerfield Telephone Company operates an exchange at this place with 80 subscribers, and one at Hughes Spring, Cass County, with 50 subscribers. A 100-drop American Electric switchboard is installed here. Messrs. Truitt & Willis are the proprietors.

LAGRANGE, TEX.—The Fayette County Telephone Company has recently made an arrangement with the Commercial Telephone Company whereby it gets long distance connection to all the principal cities in Texas. At Lagrange a 200-drop American Electric switchboard is used; there are 140 subscribers and 100 miles of toll line. The rates are $2.50 and $1.50 per month.

BROWNWOOD, TEX.—Mr. C. H. Woodward, sole owner of the Telephone Exchange here, contemplates installing 10,000 feet of cable in the Spring and substituting metallic circuit where common return system is now used. He will also rebuild the principal toll lines and double the switchboard capacity. It is Mr. Woodward's intention to organize a company with $50,000 paid-up capital. Kellogg instruments are used and there are now over 300 subscribers, with 150 miles of toll line in the system.

ST. JOHNSBURY, VT.—The Citizens' Telephone & Telegraph Exchange numbers 700 subscribers and reports the addition of 100 of these since June of this year. Couch & Seely apparatus is used. The company is in a very healthy condition.

BARTON'S LANDING, VT.—An addition of 25 miles of toll line is projected by the Vermont People's Telephone Company, which has 700 subscribers. The company is gaining about 150 subscribers a year and the outlook is very good. D. Buchanan is manager.

GREENBACKVILLE, VA.—The Accomac & Northampton Telephone Company, of Greenbackville, has been chartered by J. T. Sharley and others; capital stock $5000.

CHARLOTTE C. H., VA.—One hundred or more miles of line and from 75 to 80 telephones are to be built and installed by the Central Telephone Company which has now 85 subscribers, and 110 miles of toll line.

PORT ANGELES, WASH.—The Angeles Telephone & Telegraph Company, capitalized at $10,000, was started in May of this year, with the stock all paid

up in full. Beginning with 95 subscribers, the company now numbers over 200. Stromberg-Carlson apparatus is used; the rates are $2.50 and $1 a month. The outlook for future business is reported good. It is planned to increase the switchboard capacity and to build lines to adjoining towns. The officers of the company are: President and treasurer, Mr. C. J. Farmer; vice-president, Mr. F. A. Jenson; secretary, Mr. C. H. Hirsch.

HUTTONSVILLE, W. VA.—The Beverly & Marlinton Telephone Company uses instruments made by Stromberg-Carlson Telephone Mfg. Company and Eureka Electric Company. The system has recently been extended by the addition of 25 miles. It has 100 subscribers.

MILWAUKEE, WIS.—The Wisconsin Telephone Company has expended over $400,000 during this year for buildings, underground conduits, toll lines, new switchboards, etc., in various parts of the state. Part of the work planned was left undone owing to the scarcity of workmen. This, however, will be completed next Spring. Two new exchanges were built in Milwaukee and two at Eau Claire and Oshkosh. The exchange at Chippewa Falls has been reconstructed and that at Steven's Point will receive new apparatus by January 1.

CITY OF MEXICO, MEX.—The original concession which the Mexican Telephone Company obtained from the Mexican Government for the establishment and operation of its telephone system in this country expired by limitation on Nov. 15. Application has been made by the company for a renewal of its concession and it is stated that the application will be granted.

ELECTRIC LIGHT AND POWER.

BIRMINGHAM, ALA.—The contract for construction work and wiring for electric light plant at the Alabama Girls' Industrial School has been awarded to the Consolidated Electric Company, of Birmingham, for $1750.

ALHAMBRA, CAL.—The Pacific Light & Power Company, Los Angeles, has secured an electric light franchise here.

CORONA, CAL.—The Corona Gas & Electric Company has made a five-year contract with the municipality here for ten arc lamps at the rate of $1000 per year.

LOS ANGELES, CAL.—The Citizens' Co-operative Gas & Electric Company is organizing at San Pedro, with a view to securing lower rates for lighting service.

STOCKTON, CAL., will get its streets lighted next year at a lower rate than any other city in the State. When the bids for the street lighting contract were opened a surprise was sprung. Both companies bid to win and the Stockton Gas & Electric Company captured the contract on the low bid of $3.69 per arc light per month. The bid of the American River Electric Company was $4.40 per light. The present rate which the city is paying the Stockton Gas & Electric Company per light is $6.90. The new rate is just $3.11 lower than the present. As the city is using just 186 arc lights a saving to the city of $578.46 per month or $6,941.50 per year will result. The Stockton Company is to use the Standard's transmitted power for all its work.

PAYETTE, IDA.—Articles of incorporation of the Payette Power Company have been filed at Boise. The capital stock will be $300,000. The power from the plant is to be used for manufacturing purposes and lighting in Payette, Ontario, Weiser and other nearby towns. Power from this plant will also be used in the operation of the proposed electric railway from this city to Emmett and Pearl. The power plant will be erected at a point on the Payette river, about three miles above Payette, where a fall of 35 feet can be utilized.

JERSEYVILLE, ILL.—The Jerseyville electric light plant was inspected recently by a party composed of Owen Ford, B. V. Beckman, J. B. Quigley and G. W. Dudley, of St. Louis, and J. M. Gore and C. D. Cole, of Quincy, Ill., preparatory to its absorption by the Union Light, Water & Traction Company, of Jerseyville, which was incorporated last week with a capital of $50,000. The incorporators were Messrs. Ford and Beckman, of St. Louis, and J. M. Gore, of Quincy, Ill. The Union Light, Water & Traction Company has also purchased the electric plant at Nevada, Mo., for $100,000 and will operate the various plants, making important improvements in the Jerseyville plant as well as increasing its capacity.

CHARLESTON, IND.—This city has voted to build a new electric light plant which will be located on Main Street near the old woolen mill. Address the town board for further particulars.

INDIANAPOLIS, IND.—Israel Hoagland, of this city, has patented an electric plow and is organizing a company to manufacture the machine. It can be applied to any farm implement requiring power for its operation. Mr. C. E. Merrifield is secretary of the company. Mr. Hoagland's address is 447 South East Street.

RICHMOND, IND.—The municipal electric light plant is now in much better condition to meet the competition of the private company than it has been heretofore. This is due to the installation of a new generator. The municipal plant will get the street lighting next year. During the past it relied solely upon commercial business and a few extra lights the city ordered.

DURANT, I. T.—At the election here on Nov. 16 it was voted to issue $89,000 water, light and sewer bonds.

COMANCHE, I. T.—The City Council has granted the Comanche Electric Company a franchise for electric light and telephone systems.

FT. MADISON, IA.—The citizens have voted to grant franchises to F. C. Wood for gas and electric lighting, electric railway and for a public heating system.

HUTCHINSON, KAN.—S. F. Johnson, City Clerk, informs us that private parties propose constructing an electric light plant in Hutchinson.

WINFIELD, KAN.—There may be an election here to vote upon the issuance of $134,000 bonds for water works, electric light plant, etc.

GIRARD, KAN.—Plans and specifications are wanted Dec. 14 for an electric light plant, capacity 50 arc, and 1500 incandescent lights. Address J. B. Grantham, City Clerk.

AUGUSTA, KY.—Bids are wanted Dec. 11 for a franchise for an electric light plant.

EATON RAPIDS, MICH.—The citizens have voted to issue $12,000 electric light bonds.

CAPAC, MICH.—The contract for furnishing a 153-hp. horizontal automatic engine to be direct-connected, and a single-phase, 60-cycle, 2300-volt 75-kw generator has been awarded to the Fisher Electric Company, of Toledo, Ohio, for $5913.

WINONA, MISS.—The Winona Water, Sewerage, Ice & Light Company is about to apply for a charter. Incorporators: Claude R. Kedson, Robt. A. Allison, Arthur Flake and others. The capital is $175,000.

McHENRY, MISS.—The McHenry Improvement Company has been incorporated, with a capital of $30,000, to erect a hotel and establish an electric light plant, water works, etc. Incorporators: D. L. O'Neal, G. A. McHenry and others.

VERSAILLES, MO.—At the recent election here the proposition to issue $10,000 electric light bonds was carried.

OMAHA, NEB.—Having its underground conduit system in the down-town district completed and the circuits installed and in operation therein, the Omaha Electric Light & Power Company is taking down its overhead wires and poles in the business portion of the city.

PATERSON, N. J.—The Public Service Corporation has installed a storage battery here which is now in service on the incandescent lighting system. The plant was furnished by the Electric Storage Battery Company, of Philadelphia, and consists of 150 cells.

PHILADELPHIA, N. Y.—Bids will be received Dec. 15 by C. T. Barr, village clerk, for the construction and equipment of an electric lighting plant for both arc and incandescent lights.

BRUSHTON, N. Y.—The Brushton Electric Light Company, of Brushton, has been incorporated, with a capital of $6500. Directors: R. E. Hiffeman, G. Walter Galsey and W. H. McCarthy, of Brasher Falls.

PHOENIX, N. Y.—A certificate of merger of the Phoenix Electric Company with the Seneca River Power Company has been filed with the Secretary of State. Both companies are incorporated to furnish light, heat and power in Baldwinsville, Phoenix and other villages in Onondaga and Oswego counties.

ST. MARYS, OHIO.—The citizens voted Nov. 28 to issue $20,000 bonds for improvements to the water works and electric light plant.

GENEVA, OHIO.—The City Council is considering the proposition of W. C. Reed, of Bluffton, for the installation of an electric light plant.

NEW CASTLE, PA.—Councilman McCaslin is investigating the cost of a municipal electric light plant.

HOOVERSVILLE, PA.—The Town Council is considering the question of constructing an electric light plant. I. M. Hoover is Borough Clerk.

GREENVILLE, S. C.—Lockwood, Green & Company, of Greenville, are preparing plans for the power development of the Southern Water Power Company.

ORANGE, TEX.—S. C. Tremble, of Hillsboro, has acquired a large interest in the Orange Ice, Light & Water Works Company and has assumed the position of general manager of the plant. Extensive improvements to the electric light system will be made.

SPARTANSBURG, S. C.—It is stated that Ladshaw & Ladshaw, of Spartansburg, have completed plans for the power development on Little Tennessee River, and have submitted the same to the syndicate of which J. S. Bailey & Company, of Waycross, Ga., are leaders. It is proposed by the syndicate to transmit this power to Atlanta, Ga., a distance of 120 miles. The plans include two dams, one 127 ft. high, the other 100 ft. high. In one power house 12 generators will be installed of 2000-kw each; the other will have eight generators of 2000-kw each. The cost of material will be for copper wire, $800,000, and poles, $252,000; the entire cost of development will be about $3,325,000.

WHITEWOOD, S. D.—It is stated that the city will purchase a larger engine for the water works, and an electric light system will be run in connection with the water works.

SAN ANTONIO, TEX.—Mayor John P. Campbell has called an election here on Dec. 19 for the purpose of determining whether $200,000 of bonds shall be issued for the purpose of building a municipal electric light and power plant.

SPRINGFIELD, TENN.—The Springfield Electric Light & Water Company has been organized here with Wm. McMurray, A. B. Porter, G. S. Moore and others as directors. The company asks for a 20-year franchise and proposes to sell its plants to the town if it desires to purchase them between the date of erection and July 1, 1905.

RICHMOND, VA.—The Electric Construction Company, of Richmond, has been awarded the contract for erecting a 300-kw electric light plant at the new pump house of the city. The contract calls for nearly $26,000.

SANTA ROSALIA, MEX.—Paul Ginther, of this place, and associates have made the necessary arrangements for the construction of an electric light and power plant here. It is stated that the work of installation will soon be commenced. The same parties will construct a modern water works system here.

CITY OF MEXICO, MEX.—A number of applications are pending in the department of fomente of the Mexican Government for concessions from parties who desire to establish electric power plants in different parts of the country. Among these proposed plants is one to be located on the Tonoco River in the state of Vera Cruz; another to be located at Xompatzal, in the state of Puebla and another on the Tulo River, in the state of Hidalgo.

THE ELECTRIC RAILWAY.

BIRMINGHAM, ALA.—The last steam dummy disappeared from Birmingham Nov. 23, when the Birmingham Railway, Light & Power Company put into operation its Powderly electric line between here and Bessemer, a distance of 12 miles.

BISBEE, ARIZ.—The City Council of Bisbee has granted a franchise to J. T. Hood, L. C. Shattuck and Neal Rogers for the construction and operation of an electric railway over the principal streets of this place. The same men propose to construct an electric interurban road between Bisbee and Don Luis.

VOLCANO, CAL.—W. H. Boydston and H. C. Shear, of Volcano, are the chief promoters of a proposed 15-mile interurban road to be built north from Volcano. Estimates on material are now being secured.

ATHENS, GA.—It is stated that the electric road from Athens to Carnesville will be built. Athens has subscribed $10,000 as an inducement for the building of the road which will be 32 miles long. W. F. Brown is the chief surveyor.

ATLANTA, GA.—The Atlanta & Marietta Electric Railway, organized to build an extension of the Georgia Railway & Electric Company's lines to Marietta, has made a mortgage to the Guaranty Trust Company, of New York, as trustee, to secure $600,000 of 5 per cent forty-year gold bonds. The bonds ($100,000) are reserved for additions and improvements.

DECATUR, ILL.—The Decatur Railway & Light Company has been incorporated to operate street railways and light, heat and power plants; capital, $1,300,000. Incorporators: W. B. McKinley, Charles Zilley, R. B. Stephens.

TERRE HAUTE, IND.—The Southern Indiana Railway Co. is surveying for a line from Terre Haute to Chicago Heights, distant about 160 miles.

HUNTINGTON, IND.—Business men of this and nearby cities are agitating the building of an electric railway from Huntington to South Bend. Meetings have been held along the line, and the project has received great encouragement.

WAVERLY, IND.—The Indianapolis & Southwestern Traction Company's line, which is projected to run from Indianapolis through Waverly to Martinsville, will be extended to Linton, Washington and Evansville. The company has recently gone through a reorganization.

WABASH, IND.—The Ft. Wayne & Southwestern Traction Company will undertake to do commercial and public lighting in the towns along the road between Wabash and Ft. Wayne. At Roanoke, Andrews and Lagro the merchants are making contracts for electric lights in their stores and houses. The company can supply the current almost 20 hours out of the 24. It will possibly furnish light for street purposes later on.

DUBUQUE, IA.—Articles of incorporation of the Midland Railway Construction Company, of Dubuque, have been filed. The incorporators and board of directors are Peter Kiene, Henry Kiene, Paul Kiene, Stephen B. Howard and Charles L. Niles.

WINFIELD, KAN.—The City Council has granted a thirty-year franchise to L. H. P. Northrup to construct and operate an electric railway system here. According to the terms of the franchise, an interurban line is to be built to Arkansas City.

MONROE, MICH.—The Detroit, Monroe & Toledo Short Line Railway Company has submitted a proposition for the purchase of the Monroe electric light plant. The purchase will depend upon the granting of a lighting franchise by the town.

MINNEAPOLIS, MINN.—It is reported that Philadelphia and Cleveland capital has been interested in an electric railway to be constructed from Minneapolis south by way of Shakopee, Faribault, Mankato and Albert Lea, Minn., from the latter place to Waterloo, Iowa Falls and Mason City, Ia. George F. Getty, of Minneapolis, is believed to have charge of the negotiations at the Minnesota end of the line, and E. M. Mabie, of Iowa, is promoting the Iowa section of the system.

VICKSBURG, MISS.—The Vicksburg Railway, Power & Mfg. Company has in contemplation the construction of a power plant at Waltersville.

ST. LOUIS, MO.—The Wabash railway system is about to instal long distance telephones all along its entire system. The lines will be the exclusive property of the Wabash Company, and will be operated for its use exclusively.

MEXICO, MO.—A meeting was held here recently to consider building an electric railway from Mexico to Memphis, Mo., for both freight and passenger service. The proposed electric line is to be run through five counties. A temporary company was organized, of which S. M. Locke, of Mexico, was made president.

BRIGANTINE BEACH, N. J.—Vice-Chancellor Emery, at Trenton, N. J., has appointed Richard D. A. Parrott, of Atlantic City, receiver for this company, on application of the Continental Trust Company, trustee, preparatory to foreclosing both the first and second mortgages of $50,000 and $25,000 respectively.

SCHENECTADY, N. Y.—The Schenectady Railway Company is to make important additions to its street railway system by extending lines through the newer portions of the city.

ALBANY, N. Y.—A certificate of incorporation has been filed with the Secretary of State for the Traction Development & Securities Company, of New York City, with a capital of $200,000. The directors are S. B. Manning, Henry Oppenheimer and C. C. Marshall, of New York City.

GENEVA, OHIO.—The Cleveland, Geneva & Meadville Electric Railway Company has applied for a franchise in Geneva for its line which will connect Geneva and Meadville, Pa.

TOLEDO, OHIO.—The Toledo Railways & Light Company is to increase the capacity of the power and lighting plant on Water Street. It is contemplated to add considerable new machinery, both for the operation of street cars and for the lighting system. It is understood the work will be started in a short time.

CLEVELAND, OHIO.—The Shaker Heights & Boulevard Railway Company will be incorporated to build a line through the new section of the city known as Shaker Heights and on to Warrensville. It is proposed to have the cars run to the center of the city over the Cedar Avenue line of the Cleveland Electric Railway, under a traffic arrangement with that company.

CINCINNATI, OHIO.—The Chester Park, Morrow & Red Bank Traction Company has been incorporated by C. E. Roth, J. E. McCracken, A. Autenheimer, W. G. Miners and others, of Cincinnati. Capital stock, $10,000. It is the intention to build a belt line connecting several of the suburban towns near Cincinnati, among them Chester Park, Bond Hill, Norwood, Oakley, Madisonville and Red Bank.

BARNESVILLE, OHIO.—The Barnesville & Woodsfield Electric Railway Company has been incorporated, with $25,000 capital stock, by G. E. Hilles, E. T. Petty, J. W. Laughlin, T. J. Buchanan, J. W. Chappell and W. E. Sharps. The company proposes to build a road from Woddsfield to Barnesville by way of Somerton and Miltonsburg. The company also proposes to supply light, heat and power to the towns through which it will operate. A considerable portion of the stock has been subscribed in the towns along the proposed line.

PORTLAND, ORE.—Articles of incorporation have been filed here by the Portland & St. Johns Railroad Company, with Francis I. McKenna, George W. Cone and William Peddicord comprising the board of directors.

NEWPORT, R. I.—The contract for the construction of the Newport & Providence Railway has been awarded, and work is to be begun at once. The company's lines will only extend to Bristol Ferry, where connections are to be made with existing lines. The road will have about 14 miles of new track.

MEMPHIS, TENN.—It is reported here that the contract has been let by the Shelby County Traction Company for the building of the interurban electric line between Memphis and Colliersville, a distance of 25 miles, to the Westinghouse Company.

NASHVILLE, TENN.—The financing of the 32-mile electric road from Nashville to Lewisburg has been completed. The road will cost $1,000,000. It will be known as the Nashville & Lewisburg Interurban Company. Dr. J. R. Shapard is president, and E. R. Richardson, secretary and treasurer.

MEMPHIS, TENN.—St. Louis capitalists have been granted a franchise for a street railway in Memphis. The new concern will be known as the City Street Railway Company. Corwin H. Spencer, vice-president of the World's Fair Association; J. C. McGaunon and L. G. McNair are the backers. The company is given until Jan. 1 to accept the terms and deposit $50,000 as a guarantee.

MEMPHIS, TENN.—The Legislative Council of Memphis has granted a franchise to the City Street Railway Company for the building and operation of an electric railway in this city. St. Louis and Memphis capitalists are interested in the project, Corwin H. Spencer and L. G. McNair, of St. Louis, being the largest stockholders. The present capitalization is $50,000, but is to be increased to $500,000.

SALT LAKE CITY, UTAH.—It is now practically certain that there will be a formal consolidation within a few weeks of the Utah Light & Power Company and the Consolidated Railway Company. The stockholders of the two companies will meet Dec. 15 and 16 to agree upon the terms of the merger. The consolidated company will then issue new bonds, and will provide for an expenditure of from $250,000 to $300,000 annually until numerous contemplated improvements are completed.

CHARLOTTESVILLE, VA.—The entire plant of the Charlottesville City & Suburban Street Railway Company has been sold at public auction for $50,000, the bondholders being the only bidders, including R. H. Wood and others. The deal includes the local lighting system. The sale was made subject to a mortgage of the Piedmont Construction Company and also to cover a lien on new rails.

MORGANTOWN, W. VA.—The Morgantown & Fairmont Traction Company has been reorganized. It is now known as the Morgantown & Pittsburg Railway Company, with a capital stock of $750,000. The incorporators are J. H. McDermott, Davis Elkins, T. R. Dille and C. R. Dille, of Morgan town, and C. W. Swisher, of Fairmont.

MILTON, WIS.—The Rock River Traction Company has been incorporated to build an electric railway from Janesville to Fond du Lac.

APPLETON, WIS.—W. H. Holcomb, of Chicago, is planning to apply to the Council for a franchise to construct an electric railway here. Mr. Holcomb is said to be interested in a project to build a line from Appleton to New London.

FOND DU LAC, WIS.—Charles D. Smith, president of the Rock River Valley Traction Company, says that his company has purchased the Janesville Street Railway Company's system, and will soon take possession of it and put it into condition for effective service. The company intends to build suburban and interurban lines, one of which is to extend from Janesville by way of Milton, Fort Atkinson, Jefferson, and Watertown to Fond du Lac. Mr. Smith has also had a survey made for an electric road from this city to Ripon and Green Lake. Most of the right of way has been purchased.

VICTORIA, B. C.—Messrs. Grant and Lloyd, of Faribault, Minn., have organized a syndicate for the purpose of building an electric railway in British Columbia, to run from Trout Lake up the Duncan River into the rich timber belts, and tap the Lardo Duncan mining region. It is said that M. B. Webber, D. A. Stewart and W. J. Landon, of Winona, Minn., are among those interested in the syndicate.

PORT ARTHUR, ONT.—Canadian and American capitalists are considering the advisability of building an electric railway to connect Fort William, Port Arthur and Duluth. Power for operating the line will be obtained by developing the Kakabeka Falls.

NEW INDUSTRIAL COMPANIES.

THE TACHER MAGNETIC SHIELD COMPANY, of Jersey City, has been incorporated; capital, $500,000. Incorporators: Charles N. King, Le Grand Bouker and W. Monds Greene.

THE WINN-CONKLIN ELECTRICAL COMPANY, of Jersey City, has been incorporated; capital, $3000. Incorporators: James E. Larrowe, Hamilton Anderson and De Witt Conkling.

THE W. S. BROWN COMPANY has been incorporated in New York City to deal in electrical supplies. The capital stock is $500 and the directors are W. S. Brown, E. D. Speer and I. L. Brown, of New York.

LEGAL.

NO MORE WESTERN UNION POLE CHOPPING.—The attorneys of the Pennsylvania Railroad Company and the Western Union Telegraph Company have arrived at an understanding whereby there will be no more chopping down of telegraph poles on the railroad company's right of way. The telegraph company has been ordered to remove its lines from the railway west of Pittsburg. The case will probably be taken to the United States Court of Appeals for decision.

TELEPHONE RATES.—In the case of J. F. Manning & Co., against the Chesapeake & Potomac Telephone Company Justice Barnard, at Washington, D. C., has declared that the act of Congress of June, 1898, fixing the telephone rates for the District does not apply to a service that provides extra equipments, such as desk instruments, etc. The decree is in accord with a recent opinion in which the Justice notified the parties concerned that they had the privilege of taking further depositions as to the reasonableness of the rates fixed by Congress.

OBITUARY.

MR. A. J. BALDWIN.—Andrew J. Baldwin, one of the first constructors of telegraph lines in this country, died in Wilkesbarre, Pa., last week, aged 79. He had the distinction of having laid the first long cable in the United States, a short line of six miles between Wood's Hole and Vineyard Haven. A second cable was laid by him between Monomoy and Grand Point, Nantucket, a distance of twenty-five miles. This line was swept away, but not before it had transmitted its first message, the news of the bombardment of Sebastopol, in 1855.

MR. A. A. HONEY.—Albert A. Honey, of Chicago, is dead from a stroke of paralysis in the Chicago Union Hospital. He was a telegraph operator, beginning when twelve years old with the old Illinois Telegraph Company. He was one of the three operators first employed by the Associated Press in Chicago. Later he entered into the employ of the Union Pacific Railroad Company, and afterward superintended the construction of the lines of the Northern Pacific from Bismarck to the Pacific Coast. Mr. Honey settled in Chicago in 1901, and until within the last six months, when illness necessitated his resignation, was president of the Magnetic Equipment Company, which was developing his inventions for increasing adhesive effect in electric traction. He was one of the organizers of the Old Time Telegraphers' Association.

PERSONAL.

MR. FRANK T. CRAVEN has resigned his position with the C. J. Field Conduit Company to represent the American Conduit Company.

MR. JULIAN S. JACKSON, formerly with the Western Electric Company, will hereafter be in charge of the Chicago office of Pass & Seymour, Inc., as sales agent.

MR. CHARLES BRANDEIS, consulting electrical engineer of Montreal, Can., is sailing on Saturday by the Cunarder *Campania* for Europe, on important business.

MR. B. MAGNUS, formerly superintendent of the refinery and silver mill of the Anaconda Company, is now associated with the Buffalo Smelter Works, at Buffalo, N. Y.

MANAGER KUNZ, of the New York offices, 143 Liberty Street, of the Pelton Water Wheel Company, has gone to Mexico with a view to closing some important contracts in that part of the world.

MR. W. C. ANDREWS, who was at one time connected with the editorial staff of this journal has become associated with the Stanley Instrument Company of Great Barrington, Mass., as engineer to the sales department.

MR. CHARLES F. CUTLER has been elected president of the Central New York Telephone & Telegraph Company, and of the Empire State Telephone Company, at a recent meeting in Utica, N. Y., of the directors of the companies.

HOUGH-BEEKMAN.—Mr. David Leavitt Hough, a well-known engineer in this city and one of the trustees of the Engineers' Club, was married last week to Miss Heloise Beekman, daughter of Mrs. W. B. Beekman, of 55 Fifth Avenue. The honeymoon is being spent in the South.

MR. LAMAR LYNDON, E. E., has just delivered a couple of excellent lectures, with experiments, on the storage battery in automobile work before the Automobile Club of America, at the New York club house. The lectures were heard with much pleasure and profit by the members.

MR. CLEVELAND MOFFETT has had an interesting article on radium and the Curies, in *McClure's Magazine*, which somehow manages to get excellent and timely articles all the time on technical and scientific sensations of the hour. Mr. Moffett spent some weeks in Paris with the Curies and their associates getting up his topic.

MR. S. T. DODD, of the Stanley Electric Manufacturing Company, Pittsfield, Mass., will lecture on "The Evolution of the Electric Railway Motor" before the New York Electrical Society, at 8 P.M., December 16. The meeting will be held at the American Institute, 19 West Forty-fourth Street. The lecture will be profusely illustrated by lantern slides.

MR. LEON W. PULLEN, of Philadelphia, is the inventor of a surface contact "push button" electric railway system which was given a trial last week at Atlantic City, N. J., on the Chelsea branch of the Pennsylvania Railroad. The contacts are saucer shaped and are installed in the center of the track, every 16 feet, or about two to an ordinary car length.

MR. A. J. de B. CORRIVEAU, of Montreal, Can., has been visiting New York. In addition to his electric railway interests, Mr. Corriveau has organized the General Automobile Club of Canada, and has now opened the first automobile garage, established in Montreal. It is quite a fine establishment. Mr. Corriveau has also been arranging for important agencies.

REAR ADMIRAL RAE, U. S. N., the new chief of bureau of steam engineering of the Navy, was guest of honor at a reception given at the Engineers' Club, New York City, on Dec. 2. It was remarkably well attended. The presentations were made by President Kafer. A great many electrical men were present, including Messrs. J. W. Lieb, L. A. Ferguson, A. Dow, R. T. Lozier, B. H. Warren, W. F. Zimmerman, T. C. Martin, E. G. Bernard, J. Barre, E. H. Mullin, E. L. Zalinski, G. H. Day, J. W. Reno, W. H. Wiley.

MR. JOHN B. McCLARY has resigned as manaker of the Street Railway Department of the Birmingham Railway, Light & Power Company, of Birmingham, Ala., his resignation to take effect January 1. Mr. McClary has been connected with street railways in Birmingham more than sixteen years, surviving several changes in ownership. Mr. McClary has announced that he will go into business for himself, but has not divulged the line of work. His successor will be Mr. Geo. H. Harris, the present traffic manager of the company.

MR. H. F. J. PORTER, who has been associated with Westinghouse interests since the first of the year and has held the position of assistant manager of the Publishing department with offices in East Pittsburg and New York, has been made second vice-president of the Nernst Lamp Company, of which enterprise Mr. George Westinghouse is president, with the duties of general manager and headquarters at Pittsburg. He assumed charge on Dec. 1. This appointment does not affect Mr. Porter's relations with the publishing department.

U. S. SENATOR CLARK, of Montana, and of the Wayclark Wire Company, is quoted as follows, in an interview about himself and copper: "One billion pounds of copper is taken from the ground annually. Of this 25 per cent. comes from Montana. I am the largest individual owner of copper mines in the world. I produce about 75,000,000 pounds a year. No, I don't think there will be any period in the near future when copper will be scarce, but one can never tell. There is no great amount of copper stored. The consumption each year about equals the production. The world is not getting ahead very much in copper. It is a mineral that cannot be overlooked, and there is more demand for it every day."

MR. LOUIS J. MAGEE, who for some fifteen years past has been prominently identified with electrical engineering and manufacturing in Germany, has returned to this country. He was early connected with the old Thomson-Houston Company and was one of the first representatives abroad of American electrical interests. At the present time he is a director in both the Allgemeine Elektricitats-Gesellschaft and the Union Elektricitats-Gesellschaft, of Berlin, and will now be their agent in the United States. He has opened an office at 25 Broad Street, New York City, and has already renewed with pleasure a great many old acquaintanceships. His health of late years has not been very robust, but the climate here suits him and, to say the least, is more sunny and genial than that of the German capital in the latitude of Labrador. Mr. Magee is quite an acquisition to local electrical circles.

DR. J. A. FLEMING, professor of electrical engineering in University College, London, concludes in *The Popular Science Monthly* for December his important series of articles on "Wireless Telegraphy." He says: "It has been often contended that whilst cables could be cut in time of war no one can cut the ether; but wireless telegraph stations in exposed situations on high promotories, where they are visible for ten to fifteen miles out at sea and undefended by any forts, could easily be destroyed. The great towers which are essential to carry large aerials are a conspicuous object for ten miles out at sea; and a single well-placed shell from a six-inch gun would wreck the place and put the station completely out of use for many months. Hence, if oceanic telegraphy is ever to be conducted in a manner in which the communication will be inviolable or, at any rate, not be capable of interruption by acts of war, the careful selection of sites for stations is a matter of importance."

MR. T. W. VARLEY.—Last Saturday evening, Dec. 5, a surprise dinner was given Mr. Thomas W. Varley at the Cafe Martin, by his old-time friends and associates of the New York Edison Company. The following gentlemen were present: Messrs. T. W. Varley, W. H. Lawrence, A. H. Ackerman, S. C. Harris, W. J. Kelly, C. H. B. Chapin, S. G. Rhodes, W. J. Chisholm, W. M. Wimpie, F. V. Magalhaes, W. T. Russell, Frank W. Wearin, A. C. Rabe, M. P. Ryder, Frank Martin, C. Van Dyck See, R. H. Willmont, Edward Durant, E. B. Powell, G. Moore, W. H. Cordell, W. H. Hill, S. D. Sprong. Mr. Varley resigned as engineer of the testing department for the New York Edison Company to accept a more lucrative position with the Boston office of the Westinghouse Electric & Manufacturing Company. Mr. Varley is a comparatively young man in the profession, and his success is due to ability and continuity of purpose. In this country he introduced a system by means of which the voltage or drop at the extreme end of an electric light circuit can be read from the mains at the power-house. This obviates the necessity of maintaining many extra "pressure wires." The Varley ground detector also locates faults on very high tension circuits while the cable is in service. His latest achievement, the Varley rotating voltmeter, gives a true reading while the meter is near a large generator where magnetic disturbances are liable to be a maximum. Kent's Pocket Book acknowledges assistance received from Mr. Varley in its compilation. Mr. Richard Varley, of Providence, R. I., the designer of improved electro magnets, is his brother.

Trade Notes.

BULLOCK ELECTRIC MFG. COMPANY, of Cincinnati, Ohio, has issued a handsome biographical calendar for December, bearing the portrait of Prof. Louis Agassiz.

BALL & WOOD COMPANY, the engine builders of Elizabeth, N. J., with headquarters in New York have now opened a Chicago office at 1247 Marquette Building, that city.

THE ELECTRIC APPLIANCE COMPANY, Chicago, refers to its Zenith lamps for the Christmas trade and reports that it has a big Chicago stock, so that it can make prompt shipments.

PLUMBAGO CRUCIBLES.—The McCullough-Dalzell Crucible Company, of Pittsburg, Pa., has issued a neat catalogue with handsome cover devoted to its various crucibles and allied apparatus, including fine dust plumbago, etc.

BROWN & SHARPE MFG. COMPANY, of Providence, R. I., has issued a handsome catalogue of its "Mechanical Machinists Tools." The catalogue under this name and numbered 105 is devoted to rules, squares, micrometer calipers, gauges and accurate test tools and is a handsome illustrated pamphlet of over 150 pages.

NORTHERN ENGINEERING WORKS, of Detroit, Mich., have just issued their crane catalogue, No. 18, intended to supplement their general crane catalogue No. 15. It is devoted more specifically to cranes for power plants, pumping stations, etc., and is of interest to engineers who design and construct power plants of all kinds.

KINSMAN ELECTRIC & RAILWAY SUPPLY COMPANY, 91 Liberty St., New York City, is putting a number of excellent specialties on the market. Among these may be mentioned its "Improved Daylight Desk Lamp" and its "Automobile Cable." Mr. Kinsman is not only a man of experience in the art but an inventor of great ability.

WOODWARD GOVERNOR COMPANY, of Rockford, Ill., has issued a descriptive illustrated catalogue devoted to its compensating type of governor for waterwheels, two models of which are intended for electric light, power and railway service. There is also a standard type for mill and factory use. Views of electrical installations are shown.

HYATT FLEXIBLE ROLLER.—The Hyatt Roller Bearing Company, of Harrison, N. J., has issued Bulletin No. 20 on the subject of its bearing as specially adapted to heavy loads at slow speeds, as on cranes, shop trucks, etc. Other bulletins of like nature deal with specific cases in other fields of work. The bulletin is illustrated and is fully descriptive.

TRUMBULL ELECTRIC MFG. COMPANY, of Plainville, Conn., is selling in large quantities its new "Ideal" cord adjuster for incandescent lamps. It consists of a rosette or block with a groove in the base, through which a cord passes with a clip on one end, which can easily be attached to any standard socket and is counterbalanced by a weight. All strain is taken from the lamp cord.

STROMBERG & CARLSON.—The Stromberg & Carlson Telephone Mfg. Company, of Chicago, has just issued in usual handsome form Bulletin No. 8, devoted to its non-multiple central energy switchboards. The boards are most elaborately and instructively described in detail, and all the parts are exhibited in excellent cuts. A feature of the catalogue is the presentation of the boards by diagram with dimensions as well as in half tones. These are great aids to an understanding of the construction and operation of the boards.

THE BISSELL COMPANY, Toledo, Ohio, has added three bulletins to its perpetual catalogue. One is devoted entirely to wires, cables and cordage; another to electroliers and chandeliers, and the third to motor starters and controllers. Each bulletin is very fully illustrated, and covers its specific subject in a very thorough manner. Tables give prices and code words of each article, and information relating to the goods is complete.

AMERICAN CIRCULAR LOOM COMPANY, of Boston, has issued to its friends a very pretty and timely panel picture for Thanksgiving, illustrative of the anniversary in the past and as it is now. The Puritan of olden days shoots his wild turkey—mighty good eating—and in contrast is the fat well-fed bird due to the modern growth of turkey culture and industrial prosperity.

COLUMBUS STORAGE BATTERY COMPANY, of Columbus, Ohio, has just issued an interesting new catalogue which lists its various types of cells and contains in addition a short treatise on the use and care of storage batteries. This is the Company's third catalogue to the electrical trade. The Columbus battery has been installed in a number of electric lighting plants, has been adopted in the telephone field, and is largely used for ignition purposes on stationary and automobile gas engines. The catalogue is illustrated and gives dimensions, capacities and prices.

THE THOMPSON-BONNEY COMPANY, 45 York Street, Brooklyn, has added to its already extensive business a new department for the sale of second-hand electrical machinery. This branch of the business will be in charge of Mr. R. B. Corbett, for many years well and favorably known in this branch of the electrical industry. A full line of electrical machinery of all types, and to suit all conditions, will be carried in stock. The Thompson-Bonney Company still retains the agency for the Fairbanks, Morse machines and is continually enlarging its repair and experimental departments.

"WATER METERS" is the title of a pamphlet just received from the Henry R. Worthington Company, whose new disc meter is described and illustrated with cuts showing the internal construction. The pamphlet also describes the standard duplex piston meter and the Worthington hot-water meter for boiler testing. The latter device has been found of great value in boiler plants for checking up the evaporative values of different kinds of coal, the efficiency of firemen, etc. This pamphlet is an innovation in the way of small leaflets. It is of the standard size for enclosure with letters 3½x6 inches, but instead of being printed upon ordinary coated paper, a high grade of tinted enamel cardboard is used, rendering the pages much more durable to handle. The pamphlet is well worth the asking.

DYNAMO FIELD RHEOSTATS.—The Wirt Electric Company, Philadelphia, Pa., through its sales department, 180 Broadway, New York City, has just issued a series of circulars and price lists of various devices produced by this well-known concern. The list includes dynamo field rheostats, special rheostats, theatre dimmers and battery charging rheostats, all of which apparatus are illustrated by several cuts. The construction of the theatre dimmer is well described. The circulars contain a great deal of crystallized information on the subjects covered. The cover of one of the pamphlets contains an embossed representation of a rheostat hand wheel, in bronze colors, which is very realistic.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DEC. 1, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

744,771. VOLTAGE REGULATOR; Alexis Le Blanc, New York, N. Y. App. filed Feb. 18, 1903. A charging switch and voltage regulator especially adapted for charging a storage battery from a small dynamo used on an automobile to supply the ignition spark. An electro-magnet in the main circuit varies the pressure upon the surface of a body of mercury to vary the extent of immersion of a resistance pencil.

745,336. COMMUTATOR BAR; William L. R. Emmet, Schenectady, N. Y. App. filed May 10, 1900. The sides of the bar are roughened to take hold of the insulation and thus solidify the commutator structure.

745,341. SWITCHING APPARATUS FOR TELEPHONIC OR OTHER SWITCHBOARDS; Frederic W. Francis, London, England. App. filed Aug. 12, 1901. Details.

745,342. ANSWERING AND RECORDING TELEPHONE; Theodore D. Freese and Carl J. Freese, Elyria, Ohio. App. filed Nov. 22, 1902. (See page 971.)

745,347. AUTOMATIC CIRCUIT BREAKER; Edward M. Hewlett, Schenectady, N. Y. App. filed April 5, 1900. Comprises fixed terminals, a straight gravitating connector, an automatic release device and an insulated tubular inclosure for the connector, connecting the terminals, forming a closed chamber when the plug is inserted.

745,348. CIRCUIT BREAKER; Edward M. Hewlett and Charles C. Badeau, Schenectady, N. Y. App. filed April 27, 1901. A circuit breaker having a pivoted tripping coil adapted to swing outwardly from the base when the circuit breaker is tripped, and main and shunt contacts on opposite sides of its axis.

745,367. ELECTRODE FOR ELECTRIC TUBE LAMPS; Daniel M. Moore, Newark, N. J. App. filed Feb. 26, 1903. To adapt the lamp for alternating currents the terminal electrodes each consist of an anode and a cathode.

745,370. ELECTRIC CIRCUIT CLOSER AND BREAKER; Thomas E. McQuon, Biggsville, Ill. App. filed Sept. 26, 1902. Details.

745,378. ELECTROLYTIC REFINING OF ZINC; Heinrich Paweck, Vienna, Austria-Hungary. App. filed March 7, 1902. (See page 971.)

745,379. MEANS FOR PROTECTING ELECTRICAL WINDINGS FROM STATIC STRAINS; John Pearson, Somerset, Wis., and Frederick R. M. Cutcheon, St. Paul, Minn. App. filed June 13, 1902. A subsidiary circuit connected at various points with the main winding contains a conductor adapted to carry abnormal voltages, but non-conductive to normal voltages.

745,382. ELECTRIC RAILWAY; William B. Potter, Schenectady, N. Y. App. filed Aug. 2, 1901. Details of a sectional conductor system.

745,383. SECTIONAL THIRD RAIL SYSTEM; William B. Potter, Schenectady, N. Y. App. filed April 23, 1902. The current for actuating the switches to direct main current into the sections of the third rail, is carried on a light overheal conductor.

745,388. TELEPHONE SYSTEM; Georg Ritter, Stuttgart, Germany. App. filed Aug. 16, 1898. (See page 971.)

745,412. ELECTRODE; Henry Blackman, New York, N. Y. App. filed Dec. 8, 1896. (See page 971.)

745,427. ELECTRIC ARC LAMP; Hubert Emonds, Aix-La-Chapelle, Germany. App. filed May 14, 1903. An electro-magnetically actuated pump removes superfluous oxygen from the arc inclosing chamber.

745,436. ELECTRIC RAILWAY SYSTEM; Frederic W. Hild, Schenectady, N. Y. App. filed April 28, 1900. Switches which control the current to the sectional conductor are arranged in groups and means are provided so that when a switch is closed, its coil is open circuited but the switch remains closed independently of its coil.

745,447. ELECTRIC IGNITER FOR LAMPS; August L. Lind, Stockholm, and Carl H. Carlsson, Liljeholmen, Sweden. App. filed April 18, 1903. Details.

745,461. ALTERNATING CURRENT METER; George Stern and Albert Lotz, Charlottenburg, Germany. App. filed April 30, 1901. A body of good conducting material adjustably mounted in the path of the flux of one of the meter windings and so placed that no turning moment will be produced thereby on the armature, the body being so mounted that it may be moved laterally with reference to the said winding so as to include more or less of the lines of force created by the winding.

745,463. WIRELESS TELEGRAPH RECEIVER; Gustaf T. Seenson, near San Pedro, Cal. App. filed Dec. 23, 1902. The relay is a carbon pencil having a gyratory motion upon a plain surface.

745,479. ANODE-HOOK; Frank W. Cann, Brooklyn, N. Y. App. filed April 9, 1902. (See page 971.)

745,488. MEANS FOR OPERATING ELECTRIC SIGNS; William Goltz, Chicago, Ill. App. filed Dec. 11, 1902. Instead of making and breaking the

circuit between the contacts of the switch, a dimming resistance is introduced, thus avoiding sparking.

745,493. PLUG FUSE; John H. Hanson, Chicago, Ill. App. filed July 31, 1903. Details.

745,494. FIXTURE FOR TERMINAL BOXES; Harry A. Hoagland, Chicago, Ill. App. filed June 29, 1903. The chandelier is suspended from a ball joint in the box.

745,502. COMBINED TROLLEY AND AIR BRAKE CONTROLLER; James Kynoch, Toronto, Canada. App. filed April 20, 1903. When the trolley wheel leaves the wire, the air brakes of the car are automatically applied.

745,507. ELECTROTHERMIC VENTILATOR; Frederic De Mare, Brussels, Belgium. App. filed June 16, 1902. The passage through which a fan drives air contains electric heating coils.

745,523. TELEPHONE SYSTEM; Georg Ritter, Stuttgart Germany. App. filed Dec. 24, 1897. (See page 971.)

745,534. ELECTRICAL ELEVATOR; Rudolph C. Smith, Yonkers, N. Y. App. filed June 14, 1901. A multipolar motor and switching mechanism for arranging the field with adjacent or alternate poles and for changing from single parallel two-brush connection to double parallel four-brush connection.

745,579. TELEPHONE EXCHANGE SYSTEM; William W. Dean, Chicago, Ill. App. filed May 9, 1901. (See page 971.)

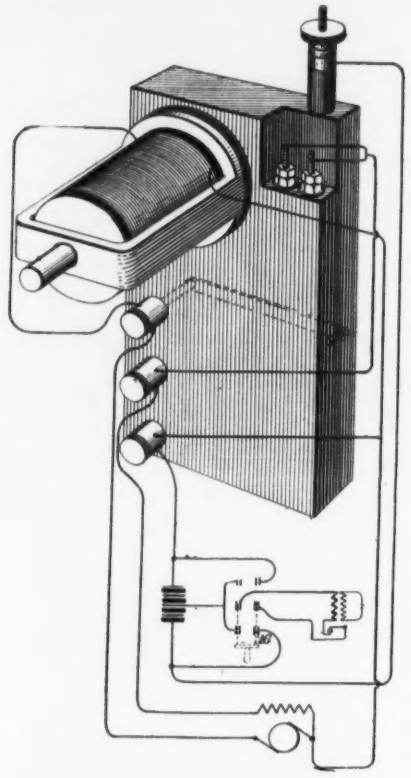
745,588. ELECTROLYTIC APPARATUS; Henry B. Ford, New York, N. Y. App. filed May 11, 1903. (See page 971.)

745,600. ELECTRIC CIGAR LIGHTING DEVICE; John W. Gray, San Francisco, Cal. App. filed April 20, 1903. Details.

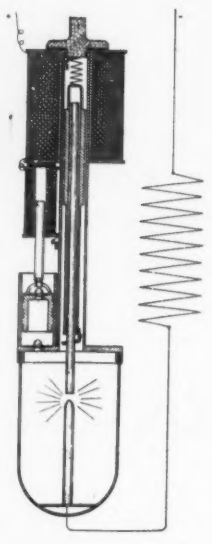
745,604. SECONDARY BATTERY; Gustave K. Hartung, New York, N. Y. App. filed Sept. 16, 1903. (See page 971.)

745,614. TROLLEY; Henry Holland, Detroit, Mich. App. filed Nov. 11, 1902. A spring plate bears directly against the wheel and the harp to carry the current.

745,622. ELECTRIC ARC LAMP; Randolph Hulsart, Brooklyn, N. Y. App. filed March 20, 1903. Details.



744,771.—Voltage Regulator.



745,427.—Electric Arc Lamp.

745,637. PROCESS OF PRODUCING CARBON CHLORIDS AND SILICON; Florentine Joseph Machalske, Brooklyn, N. Y. (See page 971.)

745,682. ELECTRICAL WATER HEATER; Milton H. Shoenberg, San Francisco, Cal. App. filed June 29, 1903. An attachment for water outlets consisting of an outgoing and return passage containing an electric heater whereby the water from the source can be sent through the passages, heated and returned to the regular outlet.

745,683. AIR PUMP GOVERNOR; Samuel B. Stewart, Jr., Schenectady, N. Y. App. filed June 21, 1901. An essential feature consists in storing energy in a freely movable contact while the pressure is fluctuating, which at a determinate position acts to open the circuit with great rapidity, as distinguished from a lock which prevents the movement of the contact until a definite position is reached.

745,687. METHOD OF BALANCING RELAYS; Henry M. Sutton, Walter L. Steele and Michael Coerver, Dallas, Tex. App. filed Aug. 15, 1902. Consists in suspending a polarized armature in the field of mutually repellant magnets, one of which is wound with divisions of the circuit extending in opposite directions around the core.

745,692. TELAUTOGRAPH; George S. Tiffany, Brooklyn, N. Y. App. filed Dec. 20, 1900. The transmitting tracing implement controls the motions of the receiving pen independently of any movement of the transmitting, writing platen.

745,694. FUSE BLOCK; Milton R. Utley and Benjamin J. Clements, Chicago, Ill. App. filed July 11, 1903. A fuse block containing an indicator to show when the fuse is destroyed.

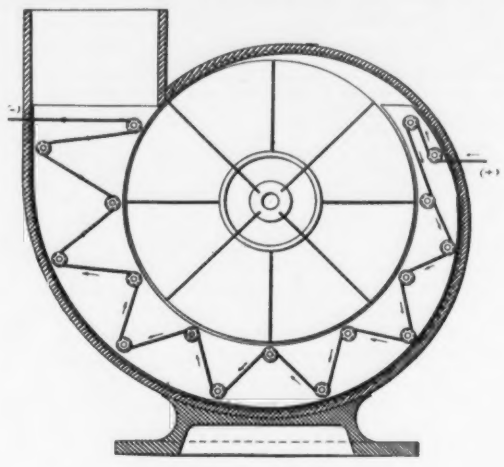
745,715. MEANS FOR MODIFYING HIGH POTENTIAL ELECTRIC CURRENTS FOR LOW POTENTIAL USE; Herbert L. Carpenter, Brooklyn, N. Y. App. filed May 15, 1903. Automatic means for preventing abnormally high potential currents on the main circuit from existing on the secondary or modified circuit.

745,759. RESISTING DEVICE; George Baehr, McKeesport, Pa. App. filed Aug. 6, 1902. A flat resistance strip is wound into a helix with interposed insulating material and its terminals connected with binding posts at the hub and rim, thus forming a resistance unit.

745,760. LEVER CONTROLLER; George Baehr, McKeesport, Pa. App. filed Aug. 6, 1902. A pivoted actuating lever and a pivoted switch blade are connected together by a stud and slot in such a manner as to give quick movement to the switch lever.

745,763. ELECTRICALLY CONTROLLED MOTOR STOPPING APPARATUS; Bertus G. Barlow, Manchester, N. H. App. filed June 16, 1903. An electro-magnetic device for actuating the throttle of an engine in emergencies.

745,772. INDUCTION MOTOR; Donald M. Bliss, Brookline, Mass. App. filed Aug. 17, 1903. The secondary member has two independent systems



745,507.—Electrothermic Ventilator.

of inductors, one of high resistance and the other of low resistance, the starting current is introduced into the former and after the machine speeds up the current is directed into the latter, thus making it possible to use a comparatively small starting current.

745,778. CONTACT BOX FOR ELECTRIC RAILWAYS; William M. Brown, Johnstown, Pa. App. filed Dec. 6, 1902. The electrodes are in a cup and an arc guard is arranged to prevent the deposit of a conducting coating on the adjoining surfaces.

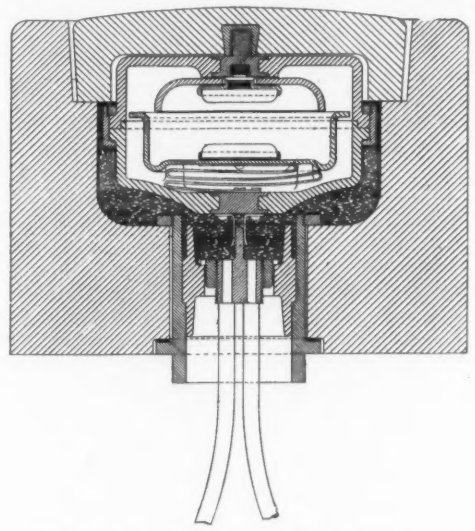
745,830. CAR LIGHTING SYSTEM; Robert F. Hall, Moseley, England. App. filed May 29, 1903. Details.

745,863. METHOD OF MELTING GLASS; Julius T. C. Kessmeier, Washington. App. filed Nov. 14, 1902. (See page 971.)

745,899. AUTOMATIC CUT OUT FOR ELECTRIC LIGHT CIRCUITS; Ralph J. Patterson, Waterville, Me. App. filed April 25, 1902. An abnormal condition on the circuit causes an electro-magnet to successively interrupt the circuit through a quick-action switch, such interruptions serving to indicate the abnormal condition.

745,926. CONTROLLER FOR ALTERNATING CURRENT MOTORS; August Sundh, Yonkers, N. Y. App. filed Aug. 5, 1903. The invention consists in the combination of an alternating current induction motor with a single controlling electro-magnet in shunt circuit therewith and hence energized by the alternating current.

745,929. ELECTRIC DISTRIBUTING SYSTEM; Rene Thury, Geneva, Switzerland. App. filed July 25, 1903. A device for limiting the differences



745,778.—Contact Box for Electric Railways.

of tension which may arise between the frames of the generators and other apparatus of the distributing system, consisting of two resistances having a neutral point connected to the masses of the apparatus which are to be protected against high static charges, the resistances being connected to the poles of the apparatus to be protected.

745,958. MANUFACTURE OF SODIUM; Thomas Ewan, Glasgow, Scotland. App. filed April 18, 1903. (See page 971.)

745,966. PROCESS OF PRODUCING SILICON CHLORIDS, HYDROCHLORIC ACID, AND ALKALI HYDROXIDS; Florentine Joseph Machalske, Chicago, Ill. App. filed Oct. 9, 1902. (See page 971.)

745,969. ELECTRIC FUSE HOLDER; James B. McCarthy, Detroit, Mich. App. filed Dec. 3, 1902. Open passages are provided at the heads of the tube to permit the escape of smoke and gases.